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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 21, 28, and DECEMBER 5.
Royal Society of Arts:—Cantor Lectures. "Alloy Steels, their Manufacture, Properties and Uses," by Professor H. C. H. Carpenter, M.A., A.R.S.M., F.R.S.

NOVEMBER 22.
Sheffield Metallurgical Association:—Ordinary meeting. "Perlit Iron—Its Properties and Uses," Paper by A. E. McRae Smith, M.A., B.Sc.

Institute of British Foundrymen.

NOVEMBER 18.
Middlesbrough Branch:—Ordinary meeting. "Mass Production of Castings," Paper by A. S. Beech.

NOVEMBER 19.
Lancashire Branch (Junior Section):—Visit to the Metallurgical Laboratories at the Manchester University, by kind invitation of Professor Thompson, D.Met., B.Sc.
Scottish Branch (Falkirk Section):—Ordinary meeting. Discussion on "Local Foundry Problems."

NOVEMBER 25.
London Junior Section:—Ordinary meeting in London. Lecture by H. J. Young.
Scottish Branch (Paisley Section):—Ordinary meeting at Paisley. "The Moulding of a Steam Hammer Cylinder," Paper by H. Hurst.

NOVEMBER 26.
Newcastle Branch:—Ordinary meeting at Newcastle-on-Tyne. "Oil Sand for Motor Cylinders," Paper by W. West.
East Midlands Branch:—Ordinary meeting at Derby. "The Control of Hardness, Softness and Soundness in Grey Iron Castings," Paper by J. E. Fletcher.

The Logical Search for New Markets.

When the steam locomotive was first developed a hundred years ago cast-iron rails were generally used, but were soon superseded by wrought iron, and then steel, on account of its low strength. In building construction, too, cast iron used to find much favour, but here again replacement by steel has been general.

There has been some talk in American foundry circles of making an effort to regain these markets, as undoubtedly a much better cast iron is now available; but steel has not been standing still all these years. It, too, has made progress, and from most mechanical aspects it is in every way preferable as a material to be incorporated where dynamic stresses are likely to be encountered, or for static stresses where weight of structure is of prime importance. Thus, in the serious search for new markets, for the regaining of old ones, it is essential that an examination is made of the present and potential properties of the alloy as are known, appreciated, and disseminated. Likewise, those of competitive materials must be similarly treated. Primarily there is the artistic treatment of cast iron, which is far cheaper to effect than with any other alloy at equal cost, the only adverse characteristic being its colour. Fortunately, however, the enamelling industry is at the service of the foundryman. After all, its main competitor, wrought steel, can only compete when the shape of the article is geometrically simple. Art is already a great factor in industry, and in the future will assume even more importance. The stereotyped ugly business or domestic premises must give way—but still retaining the use of standardised articles—to more artistic treatments. Cast-iron garden furniture, if artistic, and properly shaped and coloured, would be much more satisfactory than the crazy wood-strip and canvas contraptions sold mainly on account of the brightness of their colour. Most of these still require cushions for comfortable usage. The price of cast iron is still a great point in its favour when considering competitive alloys, and is one which must be conserved by improved means of manufacture.

The mechanical properties of cast iron, which in some directions are admirable, should be reduced not to tons per sq. in., but to potential strength property per pound sterling of cost. It is by some such logical examination and apt presentation of the present-day properties of cast iron that new markets will be found, and not by worrying engineers to turn the clock back.

Science and the Plain Man.

Many people will echo the appeal made by Sir Richard Gregory towards the end of the recent British Association meeting that the papers presented should be couched in simple English rather than in the polysyllables of the specialist. We need not concern ourselves with the immediate question of whether the British Association should regard itself as one of the many specialist scientific societies, or whether it should act as an annual forum for explaining recent scientific advances to an intelligent but not highly scientific public; the issue raised is, in fact, a much wider one.

As a modern Sir William Harcourt might have said, "We are all specialists now." Knowledge increases every year, and individual attention necessarily becomes confined to an ever narrowing field. New terms are devised, with perfect legitimacy, for adequate terminology is vital to science. Science is essentially accurate, and in the ordinary vocabulary of every-day speech the range of meaning which becomes attached to a simple term would make its undefined use in scientific work quite impossible. New terms are devised in science to mean one thing or one set of conditions, and nothing else, and the terms then become a sort of mental shorthand for those who use them, enabling them to interchange ideas without the otherwise imperative explanation of the significance of each term in cumbersome detail.

There are, however, a number of people, half-educated in science, who delight in embarrassing the non-specialist by peppering their conversation with terms which they know will be imperfectly understood by their hearers, who are rightly and justifiably irritated by such jargon-mongering.

In parallel with scientific development it is imperative that steps be taken to explain in a terminology comprehensible to the average man what the developments really mean. The process may involve a certain loss in accuracy, but it is a case of half a loaf, and in this respect to-day there is practically no bread at all. The reason is fairly clear. There are few really scientific men who possess the gift of explaining highly technical matters in a popular manner. Sir Oliver Lodge, Sir William Bragg, Professor Turner and Professor Arnold have this faculty to a remarkable degree where scientific work is concerned, just as Sir Walford Davies has it for music and Dr. Saleeby for public health. We need, however, a whole army of men with genuine scientific knowledge, with the capacity of the teacher for imparting it to less expert minds, and the facility of the journalist for interesting his readers by an attractive presentation.

This is not merely a question of the scientific explaining themselves to the non-scientific: the specialist in one branch is also anxious to understand something of the work of other branches, and he is both willing and capable of absorbing the information. But the most urgent necessity probably is for some means whereby the work of science shall become comprehensible to the non-scientific. Does this not lie at the root of some of our industrial difficulties? How much of the

jealousy that often exists between one department of a works and another is due to such lack of mutual understanding? How often is the difficulty of persuading a managing director or other superior officer to take some course of action due to inability to convince him of its importance? How much of the lack of tolerance between the practical man and the technical man is due to their mutual inability to explain their jobs in terms the other will understand? If this is so—and it can hardly be denied—then assuredly the matter is of primary and particular importance in the foundry world.

Correspondence.

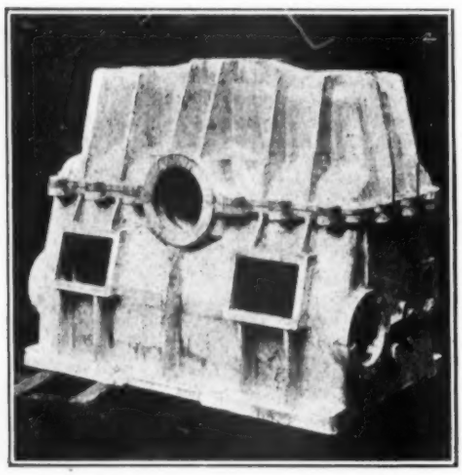
[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

"Britain's Largest Aluminium Casting."

To the Editor of The Foundry Trade Journal.

Sir,—I have read with interest in The Foundry Trade Journal of November 3 a short description of what is claimed to be the largest aluminium casting yet made in Great Britain.

As you are welcoming correspondence on this matter, I would inform you that under my supervision as a foreman of a large aluminium foundry*, a number of much larger aluminium castings pass through my hands. I am not able accurately to judge the size of the casting you illustrate, but by appearances the man is on the short side, but I am enclosing a photograph of an aluminium



gear-box casing, one of a number which I often cast, and the size of this is: *Top half*, 5 ft. × 2 ft. 7 in. × 1 ft. 7½ in.; *bottom*, 5 ft. × 10⅜ in. × 2 ft. 2½ in., both having a casing wall thickness of ¾ in. The weight of top portion is 4 cwt. 1 qr. 19 lbs., and the bottom portion 7 cwt. 0 qr. 3 lbs., both these weights being taken after trimming.

Apart from this casting being very large and heavy, it called for intricate coring, and had to be perfect in every way so as to withstand the heavy duty it was to perform; that was, to carry reduction gears, having ratios of 15 to 1 at 100 h.p. at 25 r.p.m.

I am continually casting heavy aluminium castings, and would further instance aluminium pistons, the trimming weight of which is over 5 cwt. These, too, have very difficult cores.—Yours, etc.,

E. W. Sutton.

Lewisham.
November 4, 1927.

[* Mr. Sutton is Aluminium Foundry Foreman to Messrs. J. Stone & Company, Limited, Deptford.—Ed.]

To the Editor of The Foundry Trade Journal.

Sir,—We notice in your issue of November 3 details of an aluminium casting weighing 2¼ cwt., which is claimed to be the largest casting in this metal yet made in Great Britain.

We would mention that we have for many years made castings of this weight, and larger, as normal productions, and we are at the present time producing castings of difficult design weighing 5 cwt. 3 qrs. 18 lbs. each. Even so, we should not claim that the latter is the largest casting ever made in this country, where the manufacture of aluminium alloy castings has reached a high standard.—Yours, etc.,

H. Player.

Sterling Metals, Limited, Coventry.
November 10, 1927.

To the Editor of The Foundry Trade Journal.

Sir,—With reference to the article appearing in your issue of November 3, page 90, under the heading "Britain's Largest Aluminium Casting," it may be of interest to your readers to know that for a number of years we have been making castings in modified aluminium-silicon alloy, "Alpax," specific gravity 2.65, up to 630 lbs. in weight, and all of a more intricate type than that shown in the illustration in your article.

It is not possible for us to submit photographs to you for publication, but such, together with our records, we shall be pleased to show you at our works, if you so desire.—Yours, etc.,

W. S. Knight, Works Manager.
Lightalloys, Limited.

Alpax Works, St Leonards Road,
Willesden Junction, London, N.W.10.
November 8, 1927.

Custom of the Trade.

To the Editor of The Foundry Trade Journal.

Sir,—We would thank you to be so good as to oblige us with your opinions on the two following questions:—

1. We have been making a large number of small castings (weighing about 20 lbs. each) off a wood plate pattern. After considerable use the two sides of the patterns moved about ⅛ in., causing the core to come out of centre. The castings are now rejected, the firm for whom they were made stating that the fault is ours, as we should be constantly checking the patterns.

Who does the fault rest with?

2. We have been making castings off a complicated pattern, the whole casting being cored out, and we have made well over 200 off the same pattern and core boxes. The core boxes are now worn, and the castings are rejected owing to the cores being out of centre, but this is not found out until our customers have machined them, and they inform us that they will charge the machining up to us.

Who is to blame?

Yours, etc.,

Kendor.

[Custom of the trade varies a good deal from district to district. We have had no legal training, and the following opinion is given under reserve, as we consider that such questions should be primarily referred to such organisations as the National Ironfounders' Employers' Federation. We consider that the onus is on the founder to cease manufacture the moment the pattern becomes defective and to notify the customer of their inability to produce satisfactory castings on that account. In the second case, we deem that the founder is not liable for machining costs, as it is a consequential damage, and the onus is on the customer immediately to report any defects in the casting, making a clear analogy with the first case where there was a defect in the pattern.]

A National Collection of Slides.

To the Editor of The Foundry Trade Journal.

Sir,—In the effort which we are making for the advancement of foundry technique it would be a great help if we could form a central library of lantern slides illustrating the various phases of foundry work, its appliances, materials used, etc., etc. There are a great number of slides in existence, and I feel sure that the members of the I.B.F. and others would at least loan these to such a library. The slides, when classified under different headings, could, under suitable conditions, be lent to the members of the I.B.F. who wished to lecture on some particular phase of the art. Our most urgent need is for slides illustrating actual foundry operations. Formal meetings once a month in the cities are insufficient. We must not neglect the actual workers who have to perform the various foundry tasks. It is an age of picture-goers, and our meetings are more attractive and helpful when they are suitably illustrated. Linked up with the foregoing is the question of the technical education of foundry apprentices.

The time is not far distant when all apprentices will be compelled to attend technical classes in connection with their particular trade. When that time comes the education authorities will turn to the Institute of British Foundrymen for expert advice on the best procedure. Here in Burnley this has already happened. The foundry classes are largely under the guidance of the local section of the I.B.F. At present there are four foundry classes running 1st, 2nd and 3rd year moulders' courses, and one class on pattern-making, with a total of 60 students, ranging in age from 14 to 26 years.

There is an urgent need for a suitable text book or books, simply written, and so arranged that boys of 14 could be made to understand them and find them interesting in relation to their progressive work in the foundry. We should need two books for the first and second years' course. There are plenty of general foundry books, all very good but scarcely suitable for apprentices taking a definite course of training to enable them to be efficient craftsmen. That, I take it, is our task, to keep our craft in line with national progress. The students here attend three nights a week: one evening pattern-making, theoretical and practical; one evening moulding and core-making theory; one evening practical moulding.

The last class is held in a local foundry from 7 to 9 p.m. The boys practise simple moulding and core-making. Actual demonstrations are given, and the whole sequence of operations is explained as the job develops.

I hope that these questions will be fully discussed and as a result some definite steps taken to remove some of the existing difficulties.—Yours, etc.,

W. H. Meadowcroft, M.I.Brit.F.

10, Hambledon View,
Habergham, Burnley.

Stabilising Tin Prices.

To the Editor of The Foundry Trade Journal.

Sir,—While fully recognising the weight of your arguments in answer to "Tin Producer's" letter in your issue of November 10, may I point out a few considerations in regard to the project of stabilising tin prices.

(1) The price of tin is regulated rather by the laws of supply and demand than by the cost of production. Taking the increase in American imports as a gauge of the growth in demand, we have an increase of 87 per cent. in 18 years: as against this, the world's production has increased by only 36½ per cent., the result being a rise in price of 119 per cent.

(2) With rising prices tin producers have had ample incentive to prospect for undeveloped tin resources. The small progress made in this direction tends to confirm the geologists' impression that no considerable reserves of tin remain undiscovered. This being the case, we must expect output to remain in the neighbourhood of 150,000 tons per annum, until, with the progressive exhaustion of existing sources of supply, it begins to decline.

(3) If tin-consuming industries continue to grow as they have done in the past 18 years, a simple arithmetical calculation shows that we must expect prices to reach approximately £350 by 1930. This does not represent profiteering on the part of producers, but is the simple result of the operation of natural laws.

(4) Under these circumstances to advertise tin, as you suggest, would be to court famine. Any form of price control must of necessity be supplemented by careful husbanding of existing resources, development of the recovery of secondary

tin, gradual introduction of substitutes, and the discouragement of speculation. If this course is adopted the tinplate and other tin-consuming industries will be relieved of their present uncertainty in regard to tin prices, and the famine for which we are actually heading will be to some extent averted.

(5) The fact, to which you refer, that tinplate prices have risen only 30 per cent. since the war, as against a much greater rise in the price of tin, has but small bearing on the present state of the tinplate industry. When it is remembered that tinplate contains only about 2 per cent. of tin it is evident that tin prices have very little to do with the price of tinplates.—I am, sir, yours, etc.,

A. P. L. GORDON.

10, Old Square, Lincoln's Inn,
London, W.C.2.
November 14, 1927.

National Wealth.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As a wrong spirit may be read into my Presidential Address on the above subject through the omission of two words in the account you give of it in your current issue of the FOUNDRY TRADE JOURNAL, will you please allow me to state that the words "and employees'" followed the words "all the employers'" in the last paragraph of the address when delivered.—Yours, etc.,

VICTOR STOBIE.

Dunston-on-Tyne, November 14, 1927.

Publication Received.

The Syllabus of the Automobile Training College.—This private institution has wisely thought fit to include a course on foundry practice. It is conducted by Mr. F. W. Nicholson, who was at one time foundry foreman at Sir W. G. Armstrong-Whitworth & Company, Limited, Close Works, Gateshead, and includes:—

Metallurgy.—Cast iron; aluminium; phosphor bronze; brass; lead; copper; tin.

Fuels.—Foundry coke; gas coke; coal; and gas.

Melting.—Cupola furnace; brass and aluminium furnace; gas furnace; fluxes, etc.

Foundry Sands and facing materials.

Moulding.—Green sand; dry sand; machine moulding; and core making. Use of "core" and moulding drying stoves, etc.

Practical Work.—Making and casting automobile cylinders (air and water cooled); aluminium crank-cases; gear cases; pistons; brass and phosphor-bronze castings. Cupola Furnace Practice: Method of mixing metals to chemical analysis, dressing and testing; shrinkage; curving; fracture; annealing; estimating; costing; foundry supervision and management, etc.

Overhauling and Repair Shops.—Complete overhaul of all the units of the motor car chassis. Power unit (crankshaft, big ends, main bearings, pistons, etc.). Dismantling the gear box and back axle units. Re-assembling and lining up the two units with the engine. Dismantling front axle, steering, universal joints, propeller shafts, road shafts, back axle and brakes. The axles are assembled and the track and lock of the wheels verified and trued. Completely overhauling the engine. Renewing the bearings where necessary, otherwise letting up, renewing piston rings, decarbonising cylinders, valve grinding, removing play between crankshaft and main bearings. Refitting tappet gear. Refitting clutch. Renewing universal pins and bushes. Refitting ball races in gear box. Renewing gears where necessary. (Turning up transmission brake drums.) Relining brake shoes. (Turning out rear wheel brake drums.) Assembling and testing. Location of faults and minor adjustments, etc.

Undoubtedly an automobile engineer will appreciate much better the fundamentals of his profession by undergoing such a training. The college is situated at Sydney Street, King's Road, Chelsea, London, S.W.3, and in order to insure a practical base for instruction it has put into production a few 2-stroke motor-cycle engines, which are sold.

Random Shots.

Sir Henry Fowler's recent address to the Institution of Mechanical Engineers has aroused very great interest, dealing as it does at considerable length with the dependance of development in engineering upon developments in the theory and practice of metallurgy. He gives in illustration such striking figures as those of the increase in cast iron production from a world total of 4½ million tons in 1850 to 77 million tons in 1926. Parallel with this he cites the growth of steel production from less than half a million tons to 90 million tons over the same period. He also compares the number of materials employed in the construction of the famous "Rocket" with those required for a modern railway engine—in the first case ordinary cast and wrought iron and a little brass; in the second, some 39 ferrous and 16 non-ferrous materials. We laugh over the multiplicity of special names for varieties of iron and other metals, but the fact is that each of these special names does signify a real development, suitability for some special purpose or provision of some special quality, and there is every sign that this will continue until there is one specific metal or brand of metal and only one considered proper for any given purpose.

* * *

Talking about special names, we need not imagine it the prerogative of the ironfounder to christen his products in fanciful fashion. The Ministry of Labour has just published a "Dictionary of Occupational Terms," and from this it is abundantly evident that the habit of allotting special names is a universal human characteristic, and one for which the founder, therefore, must not be too severely blamed! What in all our vocabulary of special irons is there, for instance, to compare with these as names of perfectly respectable and even commonplace occupations—the Tozer, the Wuzzer, the Count House Cat, or the Woffler—the latter being a gentleman who makes his livelihood by "adjusting and repairing scales on customers' premises."

* * *

Not so very long ago there was a Shipping Exhibition, at which our amazed eyes beheld the monsters of modern machinery. This was followed at no great interval by the Motor Show, where no less wonderful but slightly more domesticated specimens were to be seen. Moving down the scale we find a Motor Bicycle and Bicycle Show. . . . What comes next? Do we pass through gradations of perambulators and children's scooters to toy engines and appliances for simplifying the work of the home? Or would the mousetrap claim pride of place as the last, least, littlest specimen of modern mechanism?

* * *

As a matter of fact there are from time to time exhibitions of inventions that purport to be designed to save labour, although to the mere man it must be confessed that some of them would appear to be rather badly misnamed. We are all only too familiar with the fate of these things—if they do by any chance save labour for mistress and maid they almost invariably increase it for the unfortunate master, who gets to know from a feeling in the air, the very moment he steps over the threshold at night, that something wants mending! If it isn't the vacuum-cleaner, it is the electric iron, or the patent egg-whisk, or the cake-beater, or the dish-washer, or the bed-maker, or something else. . . . No, we have had enough of labour-saving to-day—we could do with a little more attention to the question of repair-saving!

* * *

A gentleman of some importance in his own neighbourhood, waiting on a somewhat out-of-the-way railway station, was flattered when a stranger approached him with the remark that his face seemed familiar—could he have seen it in the papers?

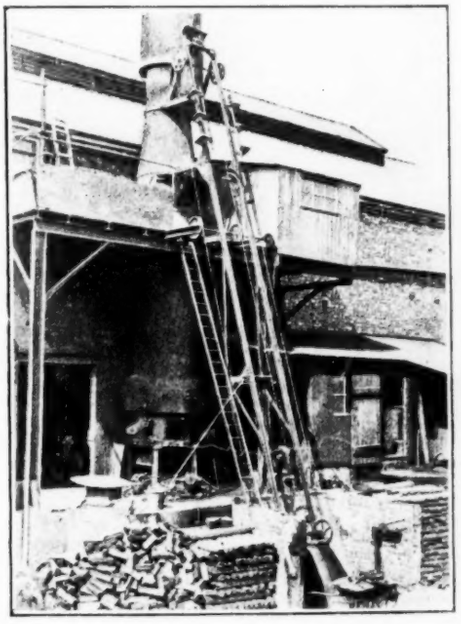
"That's more than likely," was the gratified reply.

"Ah, then I wasn't mistaken," the stranger went on. "It *was* the tobacco habit you were cured of, wasn't it? Or was it er—er—drink?"

MARKSMAN.

The Ruscoe Cupola Charger.

Messrs. John Ruscoe & Company, Limited, of Albion Works, Hyde, Cheshire, have recently designed and placed upon the market an automatic cupola feeding machine, which we illustrate below. It can be attached to existing plants, and renders the installation of a hoist unnecessary. Modern practice, even where a charging machine has not been installed, tends to insist upon the weighing of the raw materials on the ground floor owing to better supervision being more easily instituted. The elevator bucket is made of riveted steel plates. About its centre it is mounted on an axle carrying rollers. These are directly connected by connecting rods to a second pair of rollers mounted well in front of the bucket to allow for tipping. These two pairs of rollers run off the *outside* of the channels forming the inclined plane. Beneath the nose of the tipping bucket there is mounted a second axle carrying a third pair of rollers, which run *inside* the channels. Now, when the bucket reaches the level of the charging door, the channels form a sort of a Y, which allows the foremost and hindmost pairs of rollers to continue in the same straight line, whereas the second, situated beneath its nose and running inside the channels, curve off almost at right angles, and cause the bucket, pivoted at the hindmost pair of rollers to tip. This gives a positive rather than a gravity tipping action.



THE RUSCOE CUPOLA CHARGER.

Put simply, the automatic charging of cupolas is a mechanical handling proposition, and it was only natural that Messrs. John Ruscoe should utilise their considerable experience in this branch of engineering for providing the foundry industry with an obvious modern necessity.

Obituary.

THE DEATH HAS TAKEN PLACE at St. Annes of Mr. P. Wild, who was for many years manager of the armour-plate department of Cammell, Laird & Company, Limited. Mr. Wild was 84 years of age.

MR. T. HARTLEY, J.P., of Joshua Hartley & Company, machinery and metal merchants, Croft Street, Bury, died last week.

SIR FREDERICK MILLS, BART., has resumed personal control of the affairs of the Ebbw Vale Steel, Iron and Coal Company, Limited, as managing director, and has appointed Mr. Hubert McVicar and Mr. Robert Graham to be joint managers of the company and its associated companies. The whole of the staff, from the managing director downwards, has been invited by the board to accept a reduction of 10 per cent. in salaries.

Notable Advance in Pulverised Fuel Firing.

From Our Own Engineering Correspondent.

It is well known that one of the objections to pulverised fuel firing has been the great length of the flame, alike for steam boilers and metallurgical furnace work. For example, in power stations with water-tube boilers, having as usual a row of burners pointing downwards, the flame is about 30 ft. long. As a result, a combustion chamber, say 50 ft. deep, is necessary, with a very high overall setting of about 120 ft., or even higher. Also, mainly for this reason, little progress has been made with cylindrical boilers and in the iron and steel industries. Now, however, a great advance has been made in the shape of a new burner, of British design, on the "turbulent" principle, which enables the combustion to be complete in about 10 ft. As a result, the combustion chamber volume in a water-tube boiler can be reduced by about 50 per cent., representing a great saving in capital cost, while the importance for all kinds of furnace work will be obvious.

Also, this new burner will take up to 150,000,000 B.Th.U., say 5 to 6 tons of coal, per hour for a single unit, so that instead of 10 to 12 burners for a boiler of 200,000 lbs. per hour evaporation, only three or four are necessary. The design is the result of extended investigations by the research staff of a very prominent firm in the field of pulverised fuel firing, and the perfected design has been operated in England continuously for a number of months past, while it is to be fitted on the new Hams Hall power station at Birmingham. Also, a solution is claimed for other difficult problems in turbulent burner design, such as low air pressure and power consumption, elimination of "stratification" troubles at the burner, absence of complicated parts, one simple adjustment only, and ability to stand the heat.

In general, 15 per cent. of the total volume of the air at only about 2 in. W.G. is supplied direct to the centre of the burner, along with all the coal, in straight line flow, while 85 per cent. of the total volume, as secondary air, enters in a concentric casing at 1 in. W.G. This secondary air is given a violent cyclonic motion in addition to that of the primary air and fuel, so that separation of air and coal particles at the burner tip is impossible, irrespective of what happens in the primary air circuit in the way.

Also, the only adjustment necessary is a single slide damper on the secondary air supply pipe, and when once "set" no further control is required to give complete combustion. Hitherto, turbulent burners have been largely dependent upon the personal skill of the operator, with constant adjustment necessary to suit varying steam demands and other conditions. Further, the new burner will take equally well, solid, liquid, or gaseous fuel, a highly important matter in the iron and steel industries as regards blast furnace gas and coke oven gas.

I.B.F. Exchange Papers at Overseas Conferences.

Mr. F. A. Melmoth will present a Paper to the Conference of the American Foundrymen's Association in 1928 on behalf of the Institute of British Foundrymen. The title of his Paper will be "Variables in Steel Foundry Practice."

The Official Exchange Paper of the Institute of British Foundrymen to the 1928 Conference of the French Foundry Association will be presented by Mr. J. W. Donaldson, B.Sc., of Greenock. He is taking for his subject, "The Heat Treatment and Volume Changes of Grey Cast Irons between 15 deg. and 600 deg. C."

Mr. H. C. Dews, of London, will present the Official Exchange Paper from the I.B.F. to the Belgian Foundrymen's Association in 1928.

Cardiff Engineering Exhibition.—The South Wales Institute of Engineers (Institute Buildings, Park Place, Cardiff) have now issued a Handbook Catalogue of this Exhibition.

I.B.F. Branch Presidents.

No. 4—The Scottish Section.

Mr. Thomas Bell comes of a well-known foundry family, both his grandfather and father being engaged in the Scottish iron trade all their lives. Apprenticed to his father as a moulder, Mr. Bell obtained his first position as a foreman in 1899 with Messrs. John Dick and Company, of Coatbridge. A few years later he moved to Edinburgh where, when in the employ of Messrs. Brown Bros. and Company, Limited, he had the interesting experience of casting many of the special gear work for both the *Mauretania* and the *Lusitania*. Mr. Bell, like most good Scotsmen, spent a few years in England, where he added to his experience by making turbine castings on the Tyne, actually in the foundry of Messrs. J. and G. Joicey and Company, Limited. Returning, in 1908, to Scotland, he put in some four years with Messrs. Fullerton, Hodgart and Barclay, at Paisley, and then ventured a little further south to Hull, where he spent an interesting time with that progressive firm, Messrs. Rose Downs and Thompson, Limited. At the beginning of the war, he once again returned to Scotland, to take charge of the foundries of Messrs. John Cochrane of Barrhead, where they specialise on marine, turbine and oil-engine castings, and still has a

Mr. Thos. Bell,
President of the Scottish Section of the I.B.F.

certain amount of pride in the fact that he supervised the making of the engine casting for H.M.S. *Rodney*. After 10 years of this class of work, he was appointed foundry manager to the Plantation Foundry of Messrs. James Howden and Company, with which firm he is still employed.

Mr. Bell claims to be one of our first readers in Scotland, and has never missed any one of the 584 issues so far published. He feels himself particularly indebted to it, as way back in 1912, when at Hull, an answer to a "Foundry Query" helped him and his firm out of a difficulty.

Mr. Bell was one of the earliest members of the Scottish section and has been extremely active ever since. His interest, like so many others, was aroused by Mr. Campion, his professor, when taking a course of metallurgical lectures for foundrymen at the Royal Technical College.

A Bellfounder's Bill of the Year 1510.

In the year 1510, when Henry VIII was king, the wardens of the church of St. Mary at Hill, near London Bridge, decided to put the bells of their church in order. To do this they called in no less than three bellfounders, Mr. William Smyth, Mr. Bullesdon and Mr. Coulverton.

The first thing to be done seems to have been to have a supper and consultation at a Mr. Sidborough's, who probably kept the Salutation Inn. At the meal, the food consisted of a shoulder of mutton, six rabbits and five chickens, with bread, ale, wine and beer. The bill for all this amounted to 4s. 2d. In spite of all these delicacies, the parties do not appear to have parted amicably, for the next stage in the business is the arrest of Mr. Smyth, and an action at law against him, which seems, however, to have been dropped.

The next difficulty to be disposed of, was to discover whether Mr. "Smyth's bell was tuneable or not," and to decide this, four of the parishioners, with the clerks of a neighbouring church, were invited to meet and to give their opinion. Wine and pears were provided to fortify them for their task. Apparently their report was in favour of Mr. Smyth, for his bell was found to be wholly satisfactory, and despite the late action taken against him a "skryvener" or professional writer was called in to make an indenture between Mr. Smyth and the wardens for the furnishing of new bells. On this occasion wine was forthcoming, probably to celebrate the re-admission of Mr. Smyth to the parochial fold.

The entry in the wardens' books reads:—

"Paid to the skryvener for making of the Indentures betwixt William Smyth bellfownder and the parish."

At the same time a Mr. Reve was summoned from the neighbourhood of Ludgate Hill. He had "brekefast" provided for him, for he had come to hear "if the 4th bell was in tune or not."

Below is given the items of the bellfounders account. It will be noticed that the founder does not charge for each bell, but for the metal of which it is made. This was a common custom: for instance, in 1487 a Mr. Nele, for casting a number of gutters, was paid for each hundredweight cast.

The Gods penny mentioned is the penny paid as earnest money to settle or establish the bargain made.

[*The Bill.*]

for brede and drynk to hym that strake the belles		iid..
strekyng [that is lowering] of the iij belles to the grounde		iis.
for a C of smale Ropis for to streke the belles	xs.	
for Drynke to the porters that holpe to stryke the belles		iid.
for the Cariage of ii belles to the fownders ..	iis.	
for to vi porters to helpe them on the slede		vi .
for xl. lb. rope for the belles, at id. quarter the lb. .. Summa	iiiis.	iid.
for wyne, at The Salutacion, (Inn) at the bargeyne makyng for the frame of the belles		viid.
for the oblygacion (or indenture) makyng, for that bargeyne..		iiiid.
for the goddis peny in honde	xls.	
to the Carpenter for his full bargayne ..	vli.	
to William howtyng for a waynskot ..		xiiiid.
for sawyng of that waynskot for the bell whelis		vid.
for Naylys for whelis of the belles ..		id.
for iiii square bolsters of Iron for the grete belles, weyng vi lb. and di.		xiiid.
for Mendyng of xii kayes for the belles ..		iid.
for makyng for boltes of Iron for your sowith bell		xd.
ror iiii bokylles for the bawdrykes of the belles		viijd.
for dressing of v stayes for the bell whelis ..		xd.
for kays for the stapulles of a bell		id.
for i c grete Naylys for the belles ..		xd.
for xii wegis of Iron for the gogeons of the belles		vid.
for the dressing of the harnes for the belles		vid.
for a bawdryke for the first bell, and for mendyng of the olde bawdrykes ..		xiiidob.
to William Smyth, fownder, for iC di. xvi lb. of newe metall to the iiiith bell, the c xxvis. viiid. Summa	xliiis.	viiid.
to William Smyth, fownder, for makyng the scripture abought the bell	xiiis.	iiid.
for mendying and garnysshyng of iii bell clapers	vs.	xd.
to Coulverton, Belfownder, for ii C xiiii lb. of Newe metall for the grete bell after xxviiis. the C. Summa	iixs.	vid.
to Bullisdon, in Bates howse, in the presens of Mr. Smart for the Rest of the grete bell, in money	xxixs.	iiiid.
for mendyng and garnysshing of the grete bell claper	iis.	iiiid.
for ii New Bawdrykes for the belles ..		xiid.
for Drynke at the hanyng vpp of the belles..		id.

Cylinders for Locomotives and Foundry Practice.*

M. Audo Answers Criticisms.

After expressing his thanks to Mr. A. S. Beech for submitting the Paper, M. Audo pointed out that the control of the blower ought not to be confined exclusively to pressure, but first and foremost to the output. The cupola might be regarded as an apparatus for burning coke. Starting from this principle it was necessary to supply it with the quantity of air necessary to effect combustion under the best possible conditions, namely, with a minimum production of CO. The pressure would be the resultant of the factors output and sections, the latter of which should be calculated liberally. Practical steps should be taken to ensure that the penetration of the blast was such that the entire mass of the materials forming the charge should be completely subjected to the action of the air.

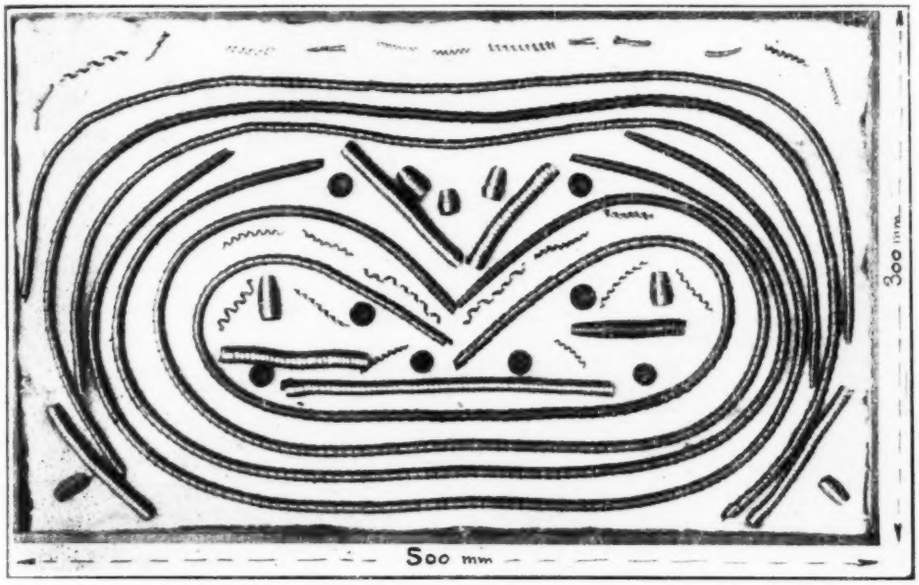


Fig. 1.

In addition to the checks carried out during the melting the automatic output meter would enable the oxidation, which was invariably caused if the pressures only were controlled, to be suppressed when the melt was finished. The furnace, in fact, was emptied at that moment. The materials offered but a feeble resistance to the blast, and if a constant pressure were relied upon a considerable excess of air was introduced, which was unfavourable to the production of sound metal. He had thus found that with an almost constant output the melt was finished with a pressure of only a few centimetres.

Errors of the Frémont Test.

The very simple standardisation of the Frémont machine in the shearing test permitted of remarkably concordant results being obtained, notwithstanding the small section of the test piece. It was precisely this small section that enabled the test to be repeated and permitted of test pieces being taken from the castings. It was this latter method which ensured of the metal of the casting itself being tested and not the metal of the melt as a whole.

The test piece might be taken either from the casting itself, or from a test bar of the same dimensions as the casting sent from the foundry with the casting and attached to it by its entire section. This method ensured that the bar should have a thermal history absolutely identical with that of the casting. It was sufficient to provide for a test bar at each part of the casting to be examined in order to ascertain the properties of the casting in all its parts.

Thus a locomotive cylinder might be provided with the following test bars:—

(*a*) One in the lower third of the cylinder body, 150 × 150 × 35 mm. (*b*) One in the upper third of the cylinder body, 150 × 150 × 35 mm., and (*c*) one on the steam chest, 150 × 150 × 30 mm.

Each test bar was separated mechanically (without shock) and then sawn into two portions, one for ball tests and chemical analysis, the other for bending and shearing test and micrographical examination.

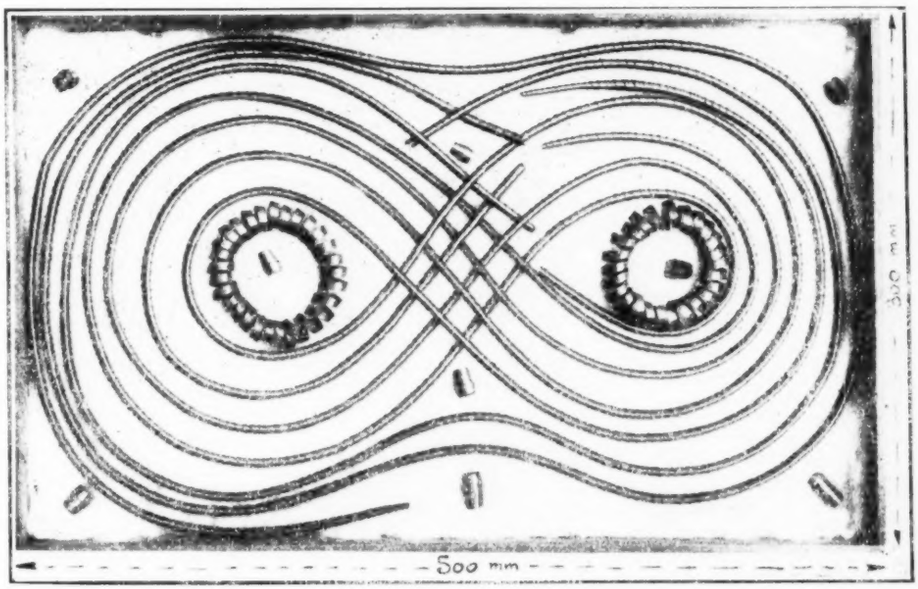


Fig. 2.

Difference Between Wear and Hardness.

It had never occurred to the author, M. Audo observed, to establish a correlation between hardness and wear. Here a regrettable confusion existed. The ball test enabled the degree of homogeneity to be ascertained owing to the ease with which it could be repeated, as also the machining capabilities of castings. He agreed with Mr. F. J. Cook in recognising that in the latter case a machining, drilling or turning test was excellent. In another connection he also agreed that neither the wear of the piston ring nor of the cylinder should be sought for, but rather the wear of that one of the two castings the cost price of which was lower. This did not mean that he recommended a soft ring. On the contrary: the Brinell numbers he had given (200 to 210) demonstrated this.

What, he asked, was the part played by the ring in the cylinder? (1) To ensure a good fit between the two faces of the piston—the property of elasticity ascertained by the transverse test (measurement of the loads and deflections, determination of the coefficient of elasticity). (2) To prevent abrasive action on the cylinder; hence the necessity for free carbon, which was a lubricating element, and, on the other hand, the necessity of avoiding hard constituents (cementite and steadite).

For segments Mr. Cook preferred a metal identical with the white metals, viz., hard crystals encased in a soft constituent. He (M. Audo) was not convinced that this view was correct. A white alloy was an intimate mixture of hard and soft crystals, the purpose of the former being to support a load which was generally high and to resist wear, while the soft constituent enabled the hard crystals to dispose themselves suitably in its mass, while conforming to the shape of the rotating chamber, itself consisting of a homogeneous metal of great hardness. The soft crystals were more subject to wear than the hard, as a result of which depressions of 5 or 6 microns, in which the lubricant was deposited, were produced on the surface of the metal. Could an identical phenomenon be looked for in the cylinder if the pressure of the segments were weak and the two metals in contact were practically identical? Could it be supposed that the very hard cementite crystals would arrange themselves in the pearlitic mass, which was itself hard (Δ = 200 to 260), according to the fineness of the lamellæ, merely under the influence of the low load due to the elasticity of the segment? Might it not be concluded, on the other hand, that, as the pearlite was worn because it was less hard, the particles of cementite would present their sharp edges and accelerate the wear as rapidly as an equal number of small high-speed steel tools would do?

M. Audo regretted that he was unable to reply definitely regarding the distances travelled, and the wear and tear in service, and that he person-

*The author's written reply to a Paper which was read before the Sheffield Convention of the Institute of British Foundrymen by M. Audo, works manager of the Paris-Orleans Railway Company.

ally could not give any other figures than those he had quoted, which, however, he regarded as satisfactory. He alluded to the wearing tests carried out by MM. B. Buffet and A. Roeder, quoting the following figures:—

Dry tests.

Number of alterations per minute	110
Area of contact	58.75 sq. cm.
Pressure per sq. cm.	293 gm.
Loss of weight:	
Cylinder metal	10 gm. in 4 days.
Pearlitic cast-iron	7 gm. in 4 weeks

Influence of the Cooling Conditions.

The divergences indicated in the carbon and the silicon contents were due: (1) To the differences in thickness of the two cylinder castings (in the body), viz., 35 to 40 mm., and of the segments 25 to 30 mm.; (2) to the differences of temperature of the moulds at the moment of casting, due to the differences in mass of the moulds and the heat losses by radiation between the time of leaving the drying stove and casting; and (3) to the differences in the rate of heat exchange due to the ratio between the mass of the castings and the mass of the moulds.

Error in the Correlative Formula.

M. Audo directed attention to the restricted limits within which the formulæ given were valid. He said that they had been drawn up merely for

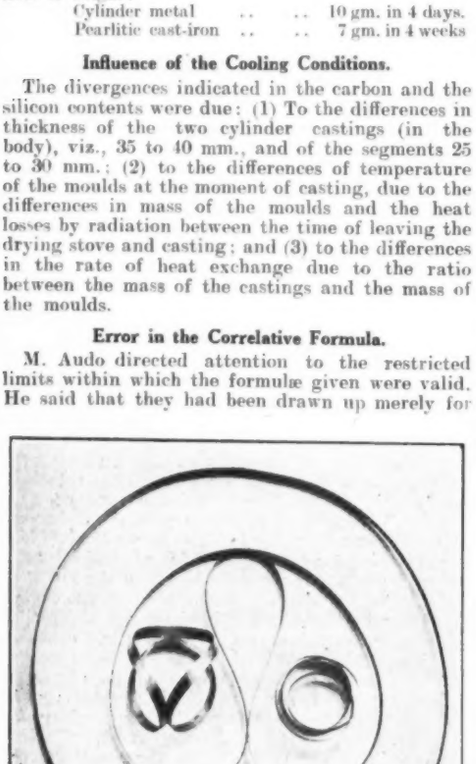


Fig. 3.

the purpose of informing the suppliers of the Company at once in case the Frémont tests were to be applied at the inspection of the castings, so as to make it unnecessary for them to carry out long and costly researches for the same purpose.

Effects of Slight Changes in Composition.

The compositions he had specified were those at present in use. No practical man, however, would imagine that they could be obtained mathematically in the cupola. These compositions were averages, and special efforts were now being made to obtain divergences of content in the different elements in proportion to the differences of speed in cooling, as already explained, and with the very definite object of obtaining the pearlitic structure in the various parts. The feeble recarburisation he had indicated was due to the presence of cupola receivers, which enabled the liquid metal to be withdrawn rapidly from contact with the liquid coke. This recarburisation was fully 0.05 per cent. of total carbon per 3 per cent. of the charge.

He did not give the process of manufacture as absolute. He had merely described it in the belief that that might prove profitable. With regard to the compositions adopted they were the result: (1) Of the study of the various factors affecting the mechanical properties of cast iron in general; (2) of an examination of the cooling conditions of the castings concerned, according to the method of manufacture adopted; and (3) of an examination of the results obtained in service—results which had been specified in his Paper and which appeared to him satisfactory.

The limits of his present note were too restricted to enable him to go into the question of the influence of the various elements contained in cast iron of different types on their mechanical properties. He would therefore beg his readers to refer to the studies already made on the subject, and more particularly to the very interesting communication of M. Portevin in March, 1927.† There they would find an account of the transverse strength and the value of the deflections, properties which were of supreme importance in the manufacture of piston rings.

With regard to the phosphorus content, and in reply to Mr. W. H. Poole, he stated that he adopted 0.2 per cent. (sometimes 0.3 per cent.) in place of 0.6 to 0.8 per cent., owing to the possibility of the formation of steadite (phosphorus eutectic), a hard and brittle constituent, the abrasive properties of which were comparable with those of cementite. Phosphorus tended, moreover, to diminish the deformation capacity on rupture. He regretted that he was unable to give particulars on the subject of centrifugal casting. He considered, however, that this method of manufacture ought to give excellent results. He wished to thank his British colleagues for the interest they had been good enough to show in his Paper, and trusted researches of a more exhaustive nature would be carried out on the subject of wear.

† See Bulletin de l'Association Technique Française de Fonderie, March, 1927.

Sand Blasting Up To Date.

By Gritstone.

Has the process of sand blasting been developed in England during the last few years to the same extent as in North America and the Continent, particularly Germany? We venture to say that it has not. Who is there that cannot picture a sand blast room or chamber as a spot to be avoided on account of dirt and dust? Yet that this is avoidable is proved by the fact that a plant designed on modern lines could and has been erected and worked on an exhibition floor, without the dust causing the slightest inconvenience to the general public. The essence of this efficient dust exhaustion from sand blast plants consists in changing the air a sufficient number of times per minute—a safe figure being 7 to 9 times per minute in the case of rooms and cabinets, and the correct dimensions and position of exhaust ports.

Compressed air is the largest cost factor in sand blasting, and care should be taken that maximum efficiency is obtained from the air generated. High pressures should be avoided, except for cleaning heavy steel castings or steel forgings. Also, nozzles of over $\frac{5}{8}$ in. diameter do not usually work efficiently, simply because the sand flow is too slow and a large volume of air is wasted. Then the cost of repairs. Such items as flexible rubber connections or hinged joints are bound to be expensive, and this type of design should be avoided. The class of abrasive used can very largely affect the final efficiency, there is no hard and fast rule, the class, either steel grit or sand, of abrasive should be studied, consideration being given to the surface to be blasted, and the finish required. Speaking generally, sand, combined with a well designed separation and exhaust system, gives the best results; steel shot or grit should only be preferred where hard scale has to be broken up.

The item which necessarily needs the most frequent renewal is the nozzle, yet how often insufficient attention is paid to this. The nozzle that gives the longest life is always the best, the broken time of changing nozzles can amount to quite an appreciable figure at the end of the week. Cheap nozzles are a fallacy.

The class of plant best adapted to the work for which it is required should receive the most careful attention; it is more usual than otherwise to find a room or chamber installed, in which the output is solely in the hands of the individual operator, whereas it is more than probable that a rotary table, or even a barrel in some cases, would have given a better finish, and certainly a bigger output. The fact should not be overlooked that a room or chamber is an extravagant unit, and should only be employed where, owing to the weight or awkwardness of the casting, a machine could not conveniently be used.

To obtain the maximum efficiency for sand blasting, great attention needs to be paid to the handling proposition. The actual time employed in sand blasting will be found, as a rule, to be a small proportion of the total time; it is, therefore, essential that the work should be fed through continuously, and that the idle time be reduced to a minimum. To obtain the best results it is often necessary to alter completely the existing shop methods of handling, and it is false economy not to do so, as far as is possible. Mechanical conveyors installed at the proper spots can altogether supersede hand labour, and can be adapted as to feed the work through on a fixed time cycle.

It seems desirable to enumerate a few classes of special work which can be dealt with by means of the sand blast, and yet which, up to the present, have not received the attention that is warranted.

Drills, Cutters and Small Tools.

It has generally been considered altogether inadvisable to sand blast such articles in a rotary barrel, it being feared that the edges of the tools would suffer and that the sand would not get into the recesses, yet it is the custom on the Continent, and has been recently adopted by some firms in this country, to sand blast drills in a barrel from $\frac{1}{8}$ in. diameter to $\frac{3}{4}$ in., solid dies can be cleaned perfectly without damaging the thread, and any class of small tool can be efficiently treated. The time saved over the vertical type cabinet is anything from 60 to 75 per cent.

Drop Forgings and Stampings.

Where machining is necessary, it is well known that the life of the milling cutters is governed very largely by the first cut; in other words, getting through the scale. If this is removed previously by sand blasting it is easy to see what an appreciable saving can be obtained. To obtain this result a rotary table or barrel machine working with steel shot or grit, and at a pressure of about 45 lbs. per sq. in., will remove all the scale, leaving a surface which will not turn the edge of the cutters.

Gas Cookers and Heating Stoves.

These form an ideal job for sand blasting, generally by means of a rotary table, though for some castings it is well to have a small chamber in addition as there are many awkward parts, such as hinge lugs, etc., where it would not pay to turn the casting over on the table and complete another revolution, it being quicker to sand blast one side on the table and face blast the local spots; this is especially necessary if the casting is being prepared for enamelling.

Cleaning of Locomotive Boilers.

An interesting design has been largely adopted on the Continent for cleaning the barrel and firebox of locomotive boilers, a saving up to 75 per cent. of the time at present occupied is obtained, and the surface on the plates remains perfectly clean for inspection.

Cleaning of Bridges, Roofs, etc.

The adoption of sand blast for cleaning steel structures is a simple and extremely effective process, and it very considerably increases the life of the paint, by giving the steel-work a thoroughly clean surface.

To sum the question up, sand blasting is a process that needs, and well warrants, careful study before installing it, especially when the handling proposition is one of importance, and it is advisable to call in the help of one used to this sort of plant and discuss the problems on the shop floor. It will probably be found that what at first sight appeared to be the best type of plant for the job will not ultimately give the most efficient results, and, as anyone connected with works management knows, it is the overhead costs that run the total costs up, and therefore man labour should be replaced as much as possible.

Modern Drying Stoves.*

By G. E. France.

The consideration of modern foundry drying stove design is a subject which ought to appeal particularly to foundrymen generally in the North-east coast, if only by reason of the fact that they are the direct descendants, in the industry, of the one man above all others who discovered and recognised the potentialities inherent in dry-sand moulding.

It is very gratifying for those whose present-day exertions are largely concentrated upon the manufacture of foundry-mould and core-drying plant, to realise that the work of John Surtees is so permanently and ably recorded in the John Surtees memorial. There can be none to-day who doubts the immense practical value which the pioneering work of John Surtees has accomplished.

The advent of the use of dry-sand moulds in place of the customary green-sand moulds for the production of castings of special importance in the iron foundry has played a great part in the subsequent development of the industrial iron foundry.

In those pioneering days the green-sand moulds were converted into dry-sand moulds by the simple expedient of the application to the mould itself of heat through the medium of fire buckets. Later on, when the value of the new method became established, the more progressive foundrymen built up a brick structure in which fire baskets or buckets were placed, and into which the moulds were carried; the fire started in the baskets and the doors closed to await the conversion. Very often no flues were provided in these primitive stoves; the products of combustion and the evaporated moisture from the moulds were allowed to make their own escape through cracks in the walls and through the badly-fitting door. As time went on and the use of dry-sand moulds became more prevalent a little more attention was sometimes paid to the construction of the stoves or ovens in which the moulds were placed to be treated. The primitive method of applying heat was still retained, but some attempt was made, by the provision of chimneys or proper outlets, to permit the egress of the waste products. For quite a considerable period iron founders were content to use this type of drying apparatus, which was obviously extremely primitive, both in design and construction.

It cannot be denied that these stoves, primitive though they were, produced dry-sand moulds. It can neither be denied that they also produced good dry-sand moulds very often in spite of the oven, and more by persistent good luck than from any definite cause, but the cost of producing moulds under these circumstances must have been far from satisfactory.

The last ten or fifteen years has seen an awakening of interest in the development of the foundry, and more attention has been paid, during this late period, to the proper equipment of the foundry. Despite this fact, it is still all too common to find foundries of quite a large size, employing quite a number of moulders, who still retain the primitive type of stove, and who pathetically expect with this out-of-date equipment to produce castings at a competitive price with other foundries more efficiently equipped.

Within the last few days the author has seen an example of this, where in a foundry employing over 200 employees three drying stoves, each one of which was 40 ft. long by 28 ft. wide by 15 ft. high, were in commission, and the only means of heating them consisting of large iron "fire devils" placed at the rear end of each stove and down the centre, with no visible means of any outlets for the products of combustion.

These stoves were built at the time the foundry was erected—somewhere in the '80s of last century. They are still producing good castings in this foundry by the use of these stoves, but they complain of severe competition, and they also complain that the effective capacity of the stove is out of all proportion to the size of the stove. They complain of the length of time the moulds have to remain in the stove before they are dried, and they most bitterly complain, when told of what their competitors are doing with the same output, of the amount of coke they are burning in their enormous fire baskets.

An Adaptation From Laundry Practice.

Another example of the same type of plant is one encountered some months ago, where a foundry had been established, incidentally for the manufacture of very intricate and high-grade castings, in a building which had been previously a laundry. With the equipment of the foundry the proprietors had decided to do as little alteration as possible, from a financial aspect presumably, and until a few months ago, at which time the foundry was dismantled and a new one erected on a better site in accordance with modern practice, all the moulds and cores were dried in what had previously been the drying place for the laundry; the only alteration that had been made was that the wooden door which had formerly shut in the wet clothes had been replaced by an iron door. This particular stove was fired by gas, and the amount of gas which it had consumed since the time the foundry had been established in the laundry premises would very nearly have paid for a new foundry.

FIG. 1.—AN AUGUST MOULD-DRYING INSTALLATION, CONSISTING OF THREE DRYING STOVES, 25 FT. × 15 FT. × 10 FT. 6 IN. HIGH, ALL FIRED BY COKE FROM ONE COMMON UNDERGROUND FLUE. REPRODUCED BY COURTESY OF MESSRS. WORTHINGTON, SIMPSON, LIMITED, NEWARK-ON-TRENT.

Evolution of the Modern Stove.

Once the art of dry-sand moulding was understood and mastered the attention of the progressive foundrymen was directed towards improving the equipment with which this class of mould could be produced, and in this respect some attention was paid to the design and construction of the mould-drying stoves, with the result there was a crop of patent types of mould and core-drying stoves which were placed on the market. The foundryman was presented with an abundance of types of stove, and after several pioneers had spent a considerable amount of money on the installation of drying stoves constructed of types which could only be regarded as experimental, and had been severely disappointed as the result of their progressiveness there naturally followed an impression that these costly experiments were costly failures, and a reversion of enthusiasm for the old original primitive type of stove set in. One unfortunate feature of this was that the definition "Patent Stove" became to be synonymous in the minds of foundrymen, with "experimental and costly stoves;" an impression which still exists.

It was natural that after the first revulsion of enthusiasm for the old primitive type of stove there should be a weeding out of the various patent types of stove, thus only the best of these patent types remain as satisfactory equipment to-day—in other words there has been a survival of the fittest.

The last ten years, and particularly the war period, has seen again the endeavours of foundrymen throughout the country directed towards the development and installation of more scientifically-controlled equipment, and this period has seen developed the very best amongst foundry mould and core-drying stoves.

Classification of Stoves.

Broadly speaking, foundry drying stoves can be separated into two classes—firstly, those which depend upon a direct application of the heat for the drying of the cores or moulds without the aid of any other means of facilitating drying, and secondly, those stoves in which the drying of the moulds and cores has been accomplished by the aid of heat augmented by a draught of air. Modern design and practice is now almost entirely concentrated upon the type of stove falling into the latter group, of which there are several types extant. Practically the only stoves of modern design and construction which are being built in accordance with the principle of the first group are stoves fired by gas, which usually consist of either a metal or brick chamber with gas jets arranged on the floor level and the products of combustion being led away at the roof, or electric ovens simply consisting of a brick or metal chamber with heating elements in the floor and sides.

Of these types, one which is finding considerable

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* A Paper read before the Newcastle Branch of the Institute of British Foundrymen, Mr. Victor Stobie presiding.

favour to-day is that type which depends for its action upon the passage through the stove of copious quantities of hot dry air produced externally to the stove. This type is now becoming almost universal in modern plant.

Fuel Available for Drying Stoves.

Various makers have naturally varying methods of construction, but this type of stove can be further sub-divided into stoves built with an external firebox above floor level, and with the products of combustion passing into the stove through one of the walls; the waste gases passing to the chimney either at the roof or through flues built in the walls. Another sub-division of this type consists of a chamber with the external firebox built underground; the products of combustion, along with the large quantities of hot air, passing into the stove by means of underground flues to the chimney. Either of these methods of firing may be adapted to stoves which already exist, and quite a lot of converting of old stoves to the new designs has been done. The fuels used in mould-drying stoves are usually confined to town's gas, producer gas, coal and coke, though there are stoves which are fired by means of powdered fuel, and also by means of oil fuel, and some small stoves are heated electrically. Generally speaking, those stoves constructed to use an external fire at floor level—that is, those stoves falling into the first sub-division—are arranged to burn coke or coal; stoves burning town's gas are almost always stoves of the very first type, and are merely chambers with gas jets along the floor level. Stoves burning producer gas usually consist of a flue just above floor level running along the wall of the stove with ports, through which the gas burns into the stove. The only examples of which the author knows in this country of stoves using powdered fuel and oil are in each case fired by means of the underground firebox and underground flues in the stove.

In the firing of stoves of small capacity the use of the external firebox above floor level, either with or without the underground flues in the stove, is a practical proposition, which is daily being used, but generally speaking this type of firing is not so successful with stoves of larger capacity. Where the size of the stove is large, the most satisfactory method is the use of the underground firebox with underground flues in the stove itself.

In the design of drying plant there are several aims which have to be kept constantly to the fore. Firstly, the plant must be efficient—a hackneyed general term which, in this case, really means that the plant must be capable of completely satisfactorily drying a mould in the quickest space of time with the smallest amount of fuel. It is, of course, possible to express this efficiency in various ways. The choice of fuel which is used is very often influenced by local conditions. Generally speaking, the cheapest fuel for use in foundry drying plant is ordinary gas coke, and where this fuel is obtainable it is easily the best to use. The drying plant designed to burn solid fuel of necessity is more costly in capital installation costs than one designed to burn gaseous fuel, but the operating costs of the two easily reverse this cost in a very short space of time.

Underlying Principles.

The principles which underlie the design of the modern foundry stove which utilises a blast of hot dry air are simple and definite. This design is based upon the fact that air is capable of holding in suspension water vapour. A simple illustration demonstrates this fact—the housewife on washing day hangs out the clothes to dry. After exposure to the air the clothes are dry, quite dry, yet they have received no application of heat. Similarly, a saucerful of water exposed in the open air evaporates in a surprisingly short space of time, leaving a bare saucer; whilst chemists will be familiar with the method of expediting the evaporation of liquids in the laboratory by means of directing a current of air across the top of the beaker or other containing vessel. It would be possible to dry moulds and cores without the application of any heat whatever if the foundryman could wait sufficiently long for the natural evaporation process aided by a blast of cold air to take place. The conditions of modern industry do not allow this cheap method, and fortunately, whilst the cold air is capable of absorbing the water vapour, the heating of the air very considerably increases its capacity to hold the moisture in suspension, so that by passing a current of hot air over the moulds, the moisture contained in the moulds is abstracted from the sand structure, and whilst still held in suspension in the volume of hot air, passes out of the stove.

In stoves designed on this principle it follows that the fire placed externally only serves the purpose of heating up the air. The actual drying of the moulds is done by the contact of this air with the sand. To expedite the drying of the moulds, and to bring this operation within the compass of industrial conditions, the design of the stove is so arranged that a continuous volume of air is passing over the fire into the stove, and then out to the chimney, and the efficiency of the stove depends upon the temperature and rapidity at which this air is passed through the stove.

The ideal stove is one which is designed in such a way that the hot air, in sufficiently copious quantities, is led into the stove, passing out of the stove quickly before the moisture which it absorbs with its first contact with the sand has attempted to recondense, and also so arranged that in its passage the air fills every portion of the interior of the stove. Such a condition can only be ensured by the design of the firebox and flues, and it is this combination of design which comprises the patent in the patent drying stoves.

When a store is filled with moulds and heat in the form of a blast of hot air applied, some time must elapse before the temperature of the stove rises above that of the boiling point of water. During this period, unless the quantity of air passing through the stove is very large indeed, the amount of moisture taken up by the air is greater than the amount the air can satisfactorily hold in suspension. In other words, the lower the temperature the lower the saturation point of moisture in air, and thus in this early stage, unless large volumes of air are used and satisfactory provision is made for the outlet of the saturated air, a large volume of heavy mist accumulates which very seriously delays the drying process. When once the stove has passed a temperature of 100 deg. C. the process becomes quite straightforward, and a smaller quantity of this hot air is capable of continuing the complete evaporation of the moisture from the sand. It follows then from the above that to ensure the most rapid drying the plant should be capable of developing a very large quantity of dry hot air at the beginning of the drying process, to ensure that the heavy mist itself does not, when formed, remain in the stove.

It also follows that the stove should be constructed so that its flues are capable of discharging this mist as it forms. It is also essential in the design of the most efficient plant to arrange these flues so that the constantly changing volume of hot air swirls into every part of the stove, so that every mould and every surface of each mould is always in contact with the evaporating stream.

Reverting for a moment to a comparison of the primitive type of stove, the advantages of the modern stove are at once apparent. In the primitive type of stove the direct application of excessive heat produces an increasing volume of water vapour which condenses immediately it comes into contact with the lower temperature of the walls of the stove, or of other moulding boxes placed farther away from the fire. This condensed moisture, as the temperature of the stove rises, is re-evaporated and re-condensed, and the cycle goes on and on until the stove is so hot that all parts of the stove are above the boiling point of water, so that all the moisture, along with the products of combustion from the fire, are forced out through the cracks of the stove. The case is very little better where a chimney flue is provided, unless such a flue extends to the floor level of the stove, and is of such a height as to ensure a sufficiently strong chimney draught to pull this heavy vapour out of the stove.

Another serious disadvantage of this direct application of heat is that those moulds placed in closer proximity to the fire ar very liable to burning, with the consequent destruction of the mould. Furthermore, with such a method it is utterly impossible to guarantee an even treatment of all the moulds in the stove. Thus it will be seen at once that the process is very unduly protracted in the primitive stove, resulting, of course, in a very considerable expenditure of fuel above that really required, besides taking up valuable time for the process, and thus holding up the production of castings.

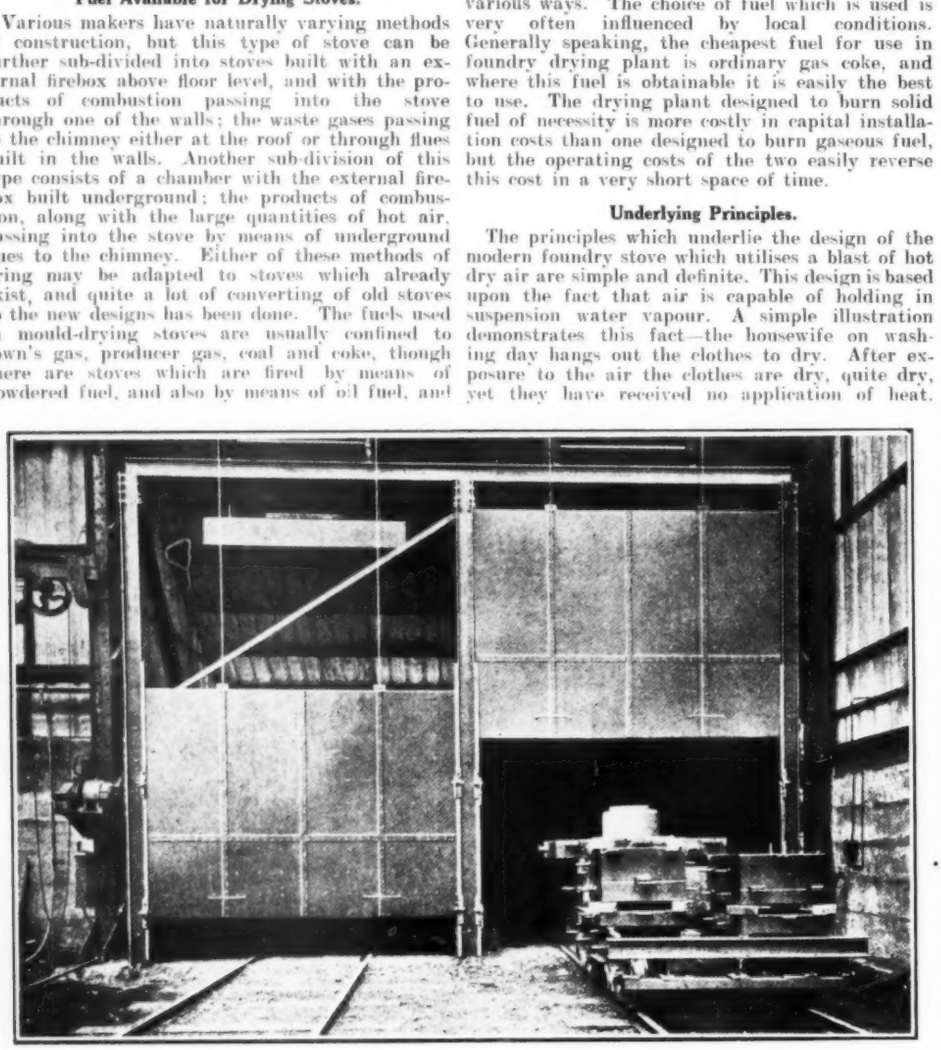

Fig. 2.—A Pair of August Drying Stoves, 18 ft. × 12 ft. 6 in. × 9 ft. high. Coke Fired with one common Underground Flue. Reproduced by Courtesy of Messrs. Davy Bros., Limited, Sheffield.

DISCUSSION.

Mr. R. H. Smith, of Messrs. Smith and Company, Limited, South Shields, at the suggestion of Mr. Stobie, gave his opinion of the drying stoves which they had installed: saying that, in his opinion, the stoves were definitely satisfactory

and that they could rely on the moulds being dry at the end of a given time, whereas in the old type they had to leave them in the stove until they *were* dry. Also, the coke consumption of the new stoves was a very great deal less than that of the old ones.

Changing the Atmosphere.

MR. MOLINEUX asked Mr. France what he considered was the volume of hot air which passed through the stove per minute or, in other words, how often the hot air in the stove was completely changed with a fresh supply of hot air from the fan. He also asked why the outlet for the saturated gases was placed in the floor. He thought it would have been found necessary to have the outlet higher up in the stove in order to get rid of the saturated gases as quickly as possible instead of taking them through the floor level. Additionally he asked whether Mr. France could give them any information about powdered coal for heating such stoves. He himself had seen what had been done in that direction in the United States, and he was very interested in the matter.

Underground Flues and Ash.

MR. C. GRESTY, referring to the underground flues, inquired as to whether much trouble occurred from collection of ash in them, and how frequently they required cleaning out. A stove which blew directly into the flues would cause no trouble as the ash could easily be removed, but in the case of underground ones it might be difficult to have to be continually opening them up to be cleaned, whilst if the flues collected much ash the moulds would be cleaner. Mr. France had mentioned one or two temperatures for drying and he would like to know what Mr. France considered the best average temperature for mould drying generally. He (Mr. Gresty) was connected with the Perlit Process, which, as they would probably all know, required the heating of the moulds before the metal was poured into them, and he would like, therefore, to know what was the maximum heat obtainable with stoves of this design. Another point which had a bearing on Mr. Molineux's question concerning the volume of hot air which passed through the stove, was whether Mr. France could give him what he considered the normal composition of the flue gas, which could be used as a check on the proper working of the stove.

MR. FLACK asked what would happen if the firebox, in the type which had two holes for blowing up the air and one for putting in the coke, was filled right up with coke.

Gas and Electric Firing Problems.

In connection with Mr. France's remarks concerning the drying stoves being heated by means of town's gas, MR. STOBIE said that he had seen big stoves heated in that way, but they were exceptionally extravagant. On burning, the gas produced water vapour which was inclined to condense on the sand. To get rid of this moisture it was necessary to raise the heat above 100 deg. C. before any drying took place, and that method could hardly be called economical. Mr. France had also mentioned electricity as a heating agent, but there they were up against the very high cost of electricity per unit of heat. In some towns it could be obtained at the price of ½d. per unit, but even then the supply necessary for evaporating water would be enormous. With electricity one could obtain an efficiency of 20-22½ per cent. in the heat. People naturally wanted to make a profit by the conversion, and the only sensible way to use drying stoves was by heating with the cheapest agency possible. Solid fuel seemed to be the heating agency with the lowest cost. As regards powdered coal, it was rather useless to attempt to use it as it created an enormous amount of ash, although, of course, there would be no clinkers. The ash would pass into the heating chambers, unless a very elaborate method was in use, but this would add greatly to the cost. Were the moulds better if heated at a fast rate, which would, of course, be best from the heat consumption point of view?

MR. FRIER said that from his experience almost anything could be burnt in the drying stoves. He had been using old coke to fire the stove and this had been quite satisfactory. With new coke a 30-ton bedplate had been fired in 30 hours. The stove had not been lined for two to two and a half years, but if a stove was filled right up as Mr. Flack had suggested, the lining would most likely be burnt out very soon, and his experience had shown that best results were obtained with only a few inches of fire on the grates.

Author's Reply.

In replying to Mr. Molineux's question concerning the rate of the passage of air through the stove MR. FRANCE said the rate differs during the course of drying. In the early stages the amount of air was small, but when the temperature rose above the boiling point of water the change of volume was almost continuous, that was, a continual stream of air was passing through the stove. In fact, one might say that the rate of the passage of air through the stove was the rate at which the air passed through the flues, which was, in the average stove, in the later part of the drying, about one minute. It had been found by definite experiment and actual practice that an outlet in the roof of the stove was a disadvantage when all outlets for waste gases were located in the floor. Perhaps that was explainable by saying that the air holding the water vapour in suspension was drawn to the floor, *i.e.*, hot air would rise and the heavy air would fall to the floor level. The most efficient designs were those which had all the flues on the floor level and none in the roof. As regards powdered coal, he had no data about its use in this country and knew of only one place where it was used, and in that case the stoves had just been converted from gas coke to powdered fuel.

FIG. 3.—THREE AUGUST DRYING STOVES, 36 FT. × 20 FT. × 8 FT. 6 IN. HIGH, CONVERTED TO RUN ON HOT AIR FROM A COMMON UNDERGROUND FLUE. REPRODUCED BY COURTESY OF MESSRS. SMITH & COMPANY, SOUTH SHIELDS.

Skilled Firing Effects Upkeep Economies.

With reference to Mr. Gresty's question concerning underground flues and the deposit of ash, it had been found by experience that the use of underground flues acted as a filter and collected what ash there was before it could collect on the moulds. Also, the amount of ash passing through the stove with the hot air was a matter dependent entirely on the skill and experience of the man looking after the stove. The ash was very slight and the flues required cleaning-out only about once in two years. In one installation the flues were not cleaned-out for over two years and when they were opened the deposit of ash found was only to a depth of 2½ in. along the bottom of the flue which was about 18 in. to 20 in. deep, so that the constriction which the ash caused was very slight. However, if the operator of the stove did not work them efficiently or fired them as he would a boiler, then they might get filled up with ash in a shorter time. The temperature at which moulds should be dried constituted a difficult question to answer, as different types of moulds would require different temperatures. The average temperature which gave the best results was 250 deg. Fah. That was, of course, when no heating of the moulds was required, as in the Perlit process. The temperature which he had given illustrating one of the slides had been for drying moulds for steel foundry work. The gas analysis varied considerably during the different periods of drying. After the stoves were once heated up and the question was merely one of providing hot air, the volume of air was so great that the resultant gas was really very little different from normal dry air, the products of combustion being so diluted as to be negligible. It had to be understood that the purpose of underground fireboxes was to provide heating units which were capable of giving up their heat to the quantity of air flowing around them. Actual practice had established the fact that the coke bed did not need to be high so long as it was clean.

Gas Firing May Be Costly.

One drying stove in the Midlands consisted of a sheet metal chamber with gas jets around the floor. The moulds dried in that stove were quite small ones for automobile cylinders and they were packed into the stove in layers which almost reached the top. Their gas bill was in the neighbourhood of £400. Roughly estimated, the cost would have been £44 using a stove with underground flues. The electric stove was arranged the same as the gas stove, with the heating units around the floor, but it was more expensive. In his opinion, it would be best to dry the moulds as rapidly as possible, as Mr. Stobie had suggested, providing that the current of air was sufficient to carry away the moisture.

The Ferro Wet Process of Vitreous Porcelain Enamelling.

By W. Marshall.

Foundry Practice and the Enamelling Department.

The fact that castings are to be porcelain enamelled is no reason for the foundry department to deliver castings that are contaminated with dirt and slag and that have a rough, uneven surface, to the enamelling department; on the contrary, if one expects to obtain good enamelling the castings must be of a good quality, free from dirt and slag, and have a smooth, even surface, free from sand and blow holes.

The patterns from which castings should be made should as far as possible be made of metal, using care that there are no thin spots or very thick places. An even distribution of metal is essential to facilitate even expansion and contraction in the enamel surfaces. These spots in castings tend to produce "cold shots," which are very hard to enamel, and in most cases cause the enamel to fly and leave the castings. They are also liable to crack at these places during the firing operation.

The castings should be designed with well-rounded angles, and sharp corners should be eliminated, as enamel will not cover sharp edges or corners; it is much better to ease such places into a liberal radius. The pattern is best run with the face in the drag. Thus the face to be enamelled is down when the metal is poured and any slag or dirt carried into the casting will float.

Gates should always be on the edge and not on the face. This is a change of practice that is really hard for some manufacturers to adopt. It is thought that a gate and riser on the edge will eliminate blow holes, dirt and sand on the face to be enamelled. The gates should be as liberal in length along the pattern as practical, and two or more gates to the piece wherever possible, the idea being to get the hot metal into the mould as rapidly and as hot as possible.

As an aid to getting the hottest metal into the piece to be enamelled, it is well to set up the moulds near the cupola. The foundry can materially assist the enamelling department by pouring castings to be enamelled from the middle of the heat, rather than from the beginning or ends; also by shaking the castings out of the sand as soon as possible.

Castings Absorb Water.

Castings to be enamelled should not be exposed to the weather or stored in places where they will absorb moisture. The best practice, wherever possible, is to transport the castings from the dressing-room directly to the sand-blast department of the enamelling plant, where they can be stored in a dry place and enamelled with as little delay as possible, as castings stored in a place where they can absorb moisture—which they readily do—when enamel is applied will rust and brown spots will show through the enamel finish; this will necessitate an additional coat of enamel. Where care is used in storing castings so that they will not absorb moisture it will be found less difficult to enamel these castings and also much cheaper as a fewer number of coats of enamel will be required.

It is not difficult to make good castings that will porcelain enamel easily, if there is co-operation between the foundry and the enamelling department, and from intimate contact with the industry it is pleasing to note that in almost every wet process plant there is perfect co-operation in this direction; also various stove and similar manufacturers have co-operated opening up their records for the benefit of the enamelling trade in general. If any foundries who are making castings for the enamelling industry will follow the few simple rules that have been taught from experience little or no trouble will result from this source.

Be as sparing as possible with foundry facings of all kinds. Eliminate them entirely if possible. If included in the iron and not removed in the sandblast, they will oxidise under the enamel, emitting gas during the burning and quite probably, cause bubbles.

Avoid printing and returning the pattern. This practice once so common in an attempt to get a smooth surface and lustrous finish is fatal to good enamelling. The included facing is almost certain to have a bad effect on the enamel and the smooth glassy surface is hard to sandblast.

Composition Sought.

The cupola mix is the one all-important item in all foundry practice, and holds true for castings to be enamelled. Experience and data to date suggest the ideal mix as near the following composition as feasible:—C.C., 0.63; Gr, 3.05; Si, 2.5 to 3.0; Mn, 0.44 to 0.54; S., 0.065 to 0.090; and P., 0.64 to 0.69 per cent. G.C., 3.05.

A reasonable variation from this analysis will not result in any harm, whilst the melting of as little foreign scrap as local conditions permit is desirable. The use of new iron will more than counterbalance its extra cost in other directions. Adherence to new iron and the above specification will minimise warped, crooked and broken castings, will result in smoother surfaces as well as save money in grinding, machine-shop labour and tools, and will give what seems to be the ideal iron for enamelling. If it is impossible to adhere strictly to the mix suggested, it is advisable at least to have the silicon above 2.50 per cent.

The writer is assured that the foregoing type of foundry practice plays an important part in getting good results in the enamelling department, and it appears to be the part to which the firms who have made a success of wet process enamelling, both in this country and in the United States, are paying strict attention.

Science and the Foundry.

At a meeting of the London Junior Section of the Institute of British Foundrymen, held in the offices of The Foundry Trade Journal, Mr. J. P. Ellis (Chairman) read a Paper entitled "Science in the Foundry."

The lecturer pointed out that science had a direct and extremely important bearing upon every phase of foundrywork. In this light, "Scientific Control" referred to the part played not only by the so-called works' chemist or metallurgist, but also by the foundry foreman, moulder, and coremaker, as all are responsible in part for the finished casting. The metallurgist is undoubtedly the most important man in this respect, as his training consists of the study of natural phenomena and the laws governing them. It should be noted, however, that a metallurgist, to be of any use, needs a considerable amount of practical knowledge and experience.

In addition to the foundry, he thought that the pattern shop and drawing office would both be better for a more scientific outlook than they generally possessed. How many pattern makers or draughtsmen had any but the most superficial knowledge of the properties of metals and the principles of foundry practice? Yet surely they were the very people who most needed that knowledge, as it rested with them whether the making of a casting was to be difficult and complicated or straightforward and comparatively easy. A knowledge of pattern-making was not definitely necessary to a moulder, but it was essential that a pattern-maker should know a considerable amount about moulding if he was to be a success at his job.

The first step towards scientific control was control over the raw materials. Every truck of pig-iron coming into the works should be sampled and analysed, and also non-ferrous metals, such as copper, zinc, tin, aluminium, etc., should be kept strictly under control. Each consignment of coke should be well sampled to control the ash- and sulphur-contents, and other materials, such as limestone, moulding sands, and core sands should be sampled occasionally.

In moulding and coremaking a great deal depends actually on the skill of the man doing the job, *i.e.*, the moulder or coremaker. A knowledge of the principles underlying the various operations is, however, invaluable, and would undoubtedly save many a casting from the scrap heap. The question of runners and risers, for instance, is one that is constantly cropping up, and nearly every moulder has different ideas on the subject.

In dry-sand and loam moulding it is very important that the correct facing is used on the mould. Every foundryman has his own pet mixture that gives better results than anyone else's, but whatever the composition, care should be taken to see that the materials used do not contain detrimental impurities.

In coremaking, the use of sharp or sea sand, with binders of the linseed-oil type, has grown immensely during the last few years. The disadvantage of the oil-sand core is that the sand can only be used once. This does not matter much in the case of foundries situated near the sea-shore or wherever the sand comes from, but the cost of carriage is a serious item if the sand has to be brought long distances.

The preparation of the molten metal should be under the direct supervision of the metallurgist. Although, of course, the moulder always blames the metal as a matter of course if he has a waster, he is sometimes justified in so doing, and it should be up to the metallurgist to see that the metal to be poured into the moulds is in perfect condition. One of the commonest faults in this respect, especially with non-ferrous metals and alloys, is the presence of oxides. Very few castings are completely free from any trace of oxide, and it can be detected microscopically in what are considered quite good test-bars. This trouble is almost wholly absent from cast iron, as that metal has nothing like the tendency to oxidise as has tin or some of the other non-ferrous metals.

The measurement of temperature is of the utmost importance in the preparation and pouring of the molten metal, as well as composition. It is here that pyrometry is of such great help to the foundryman. Not so very long ago the judgment of correct pouring temperatures depended solely upon the eye, with the result that if, for instance, several bright sunny days were followed by a very dull one, the judgments were upset and the metal probably poured too cold. Nowadays we have pyrometers which will measure up to 1,400 or 1,500 deg. C. with only a few degrees error.

In the examination of the finished casting, whether good or bad, science gives invaluable aid. Analysis should, whenever possible, be supported by microscopic examination, which is almost a science in itself.

The author then went on to describe the preparing of a specimen for microscopical examination and the many interesting and important facts to be revealed under the microscope. He pointed out how, in the case of cast iron, graphite may occur in a great variety of sizes and arrangements, from small specks to large thick plates.

The lecturer concluded by emphasising that the aim of science in the foundry should be standardisation of quality so that any number of castings may be produced or operations performed with the certainty that everyone would be exactly the same. The attitude predominating in many foundries towards the work was, "If it's a good 'un all well and good; if it's a waster make another and hope for the best." The foundryman should be in a position to know just why a casting is a waster and what to do to prevent its happening again.

He wished to thank Messrs. J. Stone & Company, Limited, and in particular Mr. Wesley Lambert, for permission and encouragement in giving his Paper.

Weight Estimating Competition.

The first prize, kindly offered by Mr. Wesley Lambert to the successful competitor in above, has been awarded to Mr. F. Cummings.

Mr. J. P. Ellis has been elected Chairman in succession to Mr. F. P. Hull, who, having left the district, has had to resign the position. The other officers of the Junior Section are as follows:—

Vice-Chairman: Mr. F. Cummings. Members of Council: Messrs. F. E. Dodsworth; R. A. Gore; H. R. Slater; F. Perry; B. Kent and V. Warren. Hon. Secretary: Miss M. D. Pittuck, c/o Mr. H. J. Young, F.I.C., 3, Central Buildings, Westminster.

Steel Making with Special Reference to the Manufacture of Steel Castings.*

By J. Deschamps.

Without considering the manufacture of alloy or special steels, it is proposed to describe briefly the various processes used at present in steel foundries for the production of plain carbon steels and to discuss their respective merits and disadvantages.

Crucible Process.

The earliest method (which was first used in Sheffield at the end of the 18th century) employed for the production of steel for the manufacture of castings was the crucible process. On account of its high cost it is practically abandoned to-day for this purpose. It consists in the melting in pots made from refractory materials (preferably of a neutral character), called crucibles, of a mixture of pure Swedish iron and charcoal.

These crucibles, which usually contain only some 50 or 60 lbs. of metal, are arranged in special furnaces, mostly coke-fired, after having been covered with closely-fitting lids to prevent oxidation.

Under the influence of the high temperature attained in the crucible furnace, the iron melts and combines with the carbon of the charcoal, the amount of which will govern the C content of the steel so produced. This process gives a very pure steel, practically free from oxides and with an S and P content, depending only on the amount of these impurities present in the raw materials employed, which is usually very low.

It is, however, a very costly process, and is only employed now in special circumstances, and for the production of very light castings. Some sixty years ago, however, some very heavy steel castings were made, at the works of Messrs. Krupp notably, where castings of several tons in weight were regularly made from crucible steel.

Open-Hearth Process.

By far the greatest tonnage of steel castings is now produced by the open-hearth process, either acid or basic, in furnaces of a capacity varying from a few tons (say, 4 to 5 tons) to 30 tons, or even more. These furnaces are either fixed ones or are equipped with a tilting device and are fired mostly with producer gas, sometimes also with fuel-oil or pulverised coal. They are fitted with regenerators, which consist of two sets of chambers (usually built under the furnace) filled with a chequer-work of refractory bricks, each set being divided in two portions.

The hot gases leaving the furnace, before going to the chimney, pass through one set of chambers and give up to the bricks part of their sensible heat, whereas the fresh gas and air, before entering the furnace, pass through the second set of chambers which have been heated previously by the hot furnace gases. After a time, through the action of a value, the currents are reversed: the air and gas being passed to the furnace through the first set of chambers, the products of combustion going to the chimney through the second set. The preheated gas and air enter the furnace by separate ports, and the combustion which follows their combination produces a very high temperature which rapidly melts the charge.

In the acid open-hearth process, this charge consists of a mixture of pig-iron low in S and P (Max. 0.04 to 0.05 per cent.) and of carefully-selected steel scrap. The other constituents (viz., Si and Mn) have not much importance, although it is better to avoid an excess of these which would unduly delay the process. No reduction of S or P can take place in the acid open-hearth process. One must therefore be very careful about the amount of these impurities present in the raw materials used, and the availability, or otherwise, of plenty of pure scrap actually governs the proportion which may be used in the mixture. Steel scrap is normally appreciably cheaper than pig-iron, and there is a distinct financial advantage in using as much of it as possible. Under favour-circumstances, as much as 75 to 80 per cent. steel scrap is used in the charge.

In the oxidising atmosphere of the furnace, oxidation of the iron takes place, and the oxide of iron thus formed, combining with the silicon of the charge, gives a silicate of iron which forms a slag floating on the metal. Similarly the Mn passes in the slag as silicate of Mn. When nearly all the Si and Mn have been thereby removed, the C of the charge is attacked and is transformed in CO (carbon monoxide) by the reaction

$$Fe_2O_3 + C = 2Fe + 3CO$$

After five or six hours (for small furnaces), or 8 to 10 hours (for large ones), all the metalloids have been removed, the temperature of the molten metal is approximately 1,550 deg. C., and it contains an appreciable amount of dissolved oxygen and oxide of iron, which are reduced by the addition of a suitable amount of ferro-manganese, the latter having usually a C content sufficiently high to recarbonise the metal to the desired extent. Ferro-silicon is also added as a deoxidiser.

The basic open-hearth process is carried out in furnaces generally similar to those used for the acid process, but the bottom, instead of being made from acid materials, such as silica bricks, is made from basic material, viz., burnt magnesite, or dolomite, and this hearth is separated from the silica bricks which form the general structure of the furnace by a layer of neutral material, usually chromite ($FeO.Cr_2O_3$).

The operation of the basic open-hearth process is similar to that of the acid process, with the exception that lime (CaO) is added with iron-ore. In the oxidising atmosphere thus created, practically the whole of the P content of the charge passes in the limey slag in the form of phosphate of calcium before the C is oxidised. S is removed only to a very small extent, since its combination with the calcium of the lime as CaS can only take place in a reducing atmosphere, which can never exist in an open-hearth furnace.

Steel made by the basic open-hearth process, although containing much less P than steel made in the acid open-hearth, is generally not of as high quality, owing to the tendency for a greater amount of oxides to be present in the bath, this being due to the highly-oxidising slag used in the basic furnace for the elimination of P, and, as we shall see later on, oxides and occluded or dissolved gases constitute the most harmful impurities to be found in steel.

Converter Process.

The Converter process is still extensively used in steel foundries, particularly the side-blown (Tropenas) converter process In its latest developments, it has proved to possess many advantages over the other processes, and these, with its inevitable disadvantages, will be mentioned later. The raw materials used in this process consist of hematite pig-iron and steel scrap containing as little P as possible. There is an obvious advantage in using as much scrap in the mixture as possible, steel scrap being much cheaper than hematite pig, and if an ample supply of low P scrap is available, there is no difficulty in using a mixture as high as 90 per cent. steel scrap and 10 per cent hematite. However, the usual proportion, in this country, is approximately 50 to 60 per cent. hematite to 50 to 40 per cent. steel scrap. This mixture of steel scrap and hematite is melted in cupolas fitted either with a receiver or with a deep well, which should be capable of holding enough molten metal to fill one converter.

The usual capacity of side-blown converters is approximately 1½ tons. The transformation of the cupola metal into steel taking about 35 minutes (namely, roughly 20 to 25 minutes blowing time and 10 to 15 minutes for the various handling operations). It will thus be seen that a 5 tons per hour cupola will be capable of supplying two 1½-ton converters, if these are blown one at a time, or three converters if occasionally two of these are blown together.

It will probably surprise many foundrymen to learn that charges consisting of 75 per cent. or more of heavy steel scrap (some individual pieces weighing as much as 4 cwts.), and 25 per cent. or less of hematite pig-iron are quite successfully melted in a cupola with a relatively low coke consumption and a high temperature in the molten metal.

In the works with which the author is associated, there is regularly melted, in 5-ton cupolas, some 40 to 50 tons per day per furnace of a metallic charge of the above-mentioned composition with 9½ per cent. melting coke, and the temperature of the metal as tapped from the cupolas in the converters varies from 1,380 to 1,420 deg. C.

The Poumay System.

At these works, some six months ago, the cupolas were equipped with a new device called the Poumay system of cupola control, which has proved to be very successful. It has enabled the management to effect an economy of some 30 to 35 per cent. on their previous coke consumption. The system is based principally on a special arrangement of what the inventor calls regeneration tuyeres, helically disposed above the wind belt of the cupola, each of which admits a different amount of air at a different pressure, with a view to burning to CO_2 inside the charges, the CO inevitably produced over the melting zone by the reduction, in contact with incandescent coke, of the CO_2 formed in the melting zone. The wind belt comprises two rows of tuyeres of much smaller total section than is the case in an ordinary cupola, thereby provoking, in the melting zone, the partial formation of CO. This creates a reducing (or at least a neutral) atmosphere at the most critical part of the cupola, which results in an appreciable reduction in the loss of valuable elements, such as Si and Mn, and also in a reduction of the amount of FeO (ferro oxide) present in the slag. Obviously, if less FeO is produced, there is less slag resulting from the combination of that FeO with SiO_2, and consequently less coke used to fuse that reduced amount of slag. It is well to remember in this connection that 1 lb. of slag requires approximately 900 B.T.U.'s for its formation.

Chrome Bricks in Melting Zone.

With a view to reduce still more the tendency to slag formation the author is at present experimenting with a neutral lining in the melting zone, consisting of chrome bricks, which should not combine either with SiO_2 or with the lime from the flux. It is hoped that the use of these chrome bricks will reduce the amount of ganister at present required for patching the cupola lining after each day's working, and will reduce also the coke consumption, since a reduction in the amount of slag produced is expected.

The theoretical C content of a charge of 75 per cent. scrap and 25 per cent. hematite is approximately 1 per cent. only. The metal, as tapped from the cupola, contains, however, about 2½ to 2¾ per cent. C, which is absorbed from the coke. The silicon is the most important element for the conversion into steel of the cupola metal, and if the average Si content of the metallic charge is less than approximately 1½ per cent. it must be supplemented by addition of ferro silicon.

Sulphur Reduction in Molten Steel.

The Tropenas process being an acid one, viz., based on the oxidation of the Si of the cupola metal in converters lined with acid material, it was, until recently, impossible to eliminate the S and the P present in the metallic charge as loaded in the cupola. Recent applications of the use of alkalies, however, have made it comparatively easy (*i.e.*, if suitable precautions are taken) to remove some 50 per cent. of the S present in the cupola metal. Therefore, the only injurious element is P, and it is now P only which is objectionable if there is more of, say, 0.06 per cent. of it in the scrap used in the charge. There is, fortunately, available in this country, an excellent quality of hematite pig-iron with a P content not

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exceeding 0.02 per cent., so that a charge in the cupola consisting of 75 per cent. of steel scrap at 0.06 P and 25 per cent. hematite at 0.02 per cent. P will yield a metal of approximately 0.05 per cent. P, which is within the limit admitted in the great majority of specifications.

Chemistry of the Bessemer Process.

When the molten metal, tapped from the cupola, has filled the converter to the requisite level the blast is turned on, and the air blows at or just under the surface of the bath, at a pressure of approximately 2 to 2½ lbs. per sq. in. A violent reaction takes place almost at once. The silicon of the metal is first oxidised in SiO_2 which, combining with FeO, forms an oxidising slag of silicate of iron. That oxidation of the silicon of the metal is an exothermic reaction which raises considerably the temperature of the bath. When nearly all the Si has been eliminated, the Mn burns in MnO_2 which passes in the slag, where it probably forms a multiple silicate of iron and manganese. This is also an exothermic reaction, but much less so than the oxidation of the Si.

The last element to be eliminated is C, which is oxidised to CO, and that CO subsequently is oxidised to CO_2 inside the vessel. At the end of the blow, which is characterised by the disappearance of the C flame, pure iron is left in the converter, and this is suitably recarbonised by the addition of ferro-alloys containing a definite amount of C. Ferro-manganese is added first. In addition to providing the C required to transform the iron into steel, it also deoxidises the bath, the Mn displacing the oxygen from FeO and combining also with whatever free oxygen remains in the steel. The best method is to make this addition of FeMn in the converter itself for two reasons: one being that, in the highly oxidising atmosphere existing at the end of the blow, the combination of Mn with the S of FeS is facilitated (and we will see later that it is highly desirable to have all the S present in the steel combined with Mn), and the other reason being that the action of the Mn will be more complete than if added in the ladle, owing to the higher temperature existing in the converter. After ferro-manganese, an addition of ferro-silicon is made in the ladle to complete the deoxidation and to remove the CO dissolved in the metal according to the reaction.

$$Si + 2CO = SiO_2 + 2C.$$

Aluminium is also used sometimes as a deoxidising agent. Both these elements (Si and Al) having a great affinity for oxygen will displace the oxygen of whatever oxides which have escaped the action of the Mn. The use of Al is, however, not to be recommended, since, when combined with oxygen, it forms Al_2O_3, a very hard compound with a high melting point, which remains in suspension in the steel and constitutes one of the worst non-metallic inclusions, the presence of which impairs considerably the quality of the steel. Ferro-titanium is sometimes used also, with a view to complete the degasification of the metal. Ti combining with dissolved nitrogen to form titanium nitride, which passes into the slag.

A relatively new type of deoxidising agent, viz., CaSi (calcium silicide), is now used with great advantage as a scavenger, the Si of this compound acting as a deoxidiser and the Ca combining with the silicates in suspension in the metal to form a double silicate of iron and calcium, which, being more fusible than the simple silicate, rises more readily in the slag.

Steel produced by the Bessemer process is charged, at the end of the blow, with a much greater amount of oxides and occluded or dissolved gases than steel made by any other process. Consequently greater care must be taken in the deoxidation and degasification of the metal, which, however, are never complete.

Electric Process.

The electric process of steel making is comparatively recent, but has made considerable strides in the last ten years, particularly in the United States, where more than 750,000 tons of electric steel are now produced annually, of which tonnage more than half is used for steel castings.

As in the open-hearth, there are two distinct processes of electric-steel making—the basic process, where a drastic elimination of S and P and a thorough deoxidation of the metal can be achieved, as will be described later, and the acid process, which requires, as the acid open-hearth process, pure raw materials, since no elimination of S or P can take place, but which enables a fairly complete deoxidation of the metal to be obtained.

The raw material consists of steel scrap of moderate sizes. Even very small material can be used without much loss. In the basic furnace, cheap scrap, high in S and P, may be used, whereas scrap for the acid furnace must be low in S and P.

Electric furnaces may be divided in three classes: those where the heating is done by resistance, those where it is done by induction, and those where the heat is produced by the electric arc. The first two classes, for various economic reasons, have not been developed to any great extent, and will be left out of consideration. The arc furnaces may themselves be divided in two classes, those where the metal is heated by radiation from the arc—now very seldom used—and those where it is heated by direct action of the arc on the metal. Finally, there are two types of direct arc furnaces, one with a conducting hearth, the other with a non-conductive hearth, both types of which are used extensively.

The load on direct arc furnaces is more or less uniform, which is an important consideration on the power-station point of view. The alternating current is usually supplied at high tension (up to 12,000 volts or even more). Passing through transformers, it is stepped down to about 100 volts. For example, in a 6-ton Heroult furnace the current delivered to the furnace is about 10,000 ampères per phase at about 100 volts. When using cold scrap the consumption of current is about 750 kw.-h. per ton of metal melted. This amount varies according to whether the basic or the acid process is used, the former requiring a greater amount of electrical energy than the latter. With the improvements recently made in electric-furnace construction, the power factor may be as high as 0.9. The current is transmitted to the bath by the electrodes, which are made either of amorphous carbon or of graphite, and are fitted, at a point where they enter the furnace, with a circulating water-cooling device to prevent their rapid burning away.

In the Basic Electric Process, which is the more extensively used, and which, when properly worked, produces steel of a finer quality than can be obtained by any other process of steel making, there are two distinct periods—the oxidation period, during which the scrap is first melted, then lime and iron oxide (iron ore) are added to form a basic oxidising slag which oxidises the Si, Mn, P and C of the metal. P, when the temperature is below 1,400 deg. C., is oxidised to P_2O_5 (phosphoric anhydride), which combines with FeO to form a ferrous phosphate. Then CaO replaces FeO to form a tricalcium phosphate, which remains stable as long as no reducing substances exist in the slag and as long as there is present an excess of CaO.

This oxidising slag, which contains, *inter alia*, all the P formerly present in the metal, is then removed, lime and coke breeze are introduced in the furnace, the doors of which are then carefully closed, so as to create a reducing atmosphere. The amount of lime and the temperature are regulated to provoke the formation of calcium carbide —CaC_2, when the following reactions take place:—

$$CaC_2 + 2FeO = CaO + 2CO + 2Fe.$$
$$CaC_2 + 2MnO = CaO + 2CO + 2Mn.$$

Ferro-silicon and ferro-manganese are added, and the following reactions take place:—

$$FeO + Mn = MnO + Fe.$$
$$2FeO + Si = SiO_2 + 2Fe.$$

$MnO + SiO_2 = MnSiO_3$, which passes in the slag.

The ferro-silicon has also the effect of removing the CO gas dissolved in the steel according to the reaction mentioned before:—

$$2CO + Si = SiO_2 + 2C.$$

A very important rôle of the carbide slag is to remove S according to the reaction:—

$2CaO + CaC_2 + 3FeS = 3CaS + 2CO + 3Fe$,

but its most important function is to deoxidise the metal.

Fluorspar ($CaFl_2$) is also added to thin the slag and to facilitate the reactions between the calcium carbide slag and the metallic oxides and sulphides.

In the Acid Process of electric steel making the scrap is melted in the usual way, but with a minimum of oxidation. Si, Mn, C are oxidised, the rust present on the scrap being usually sufficient to produce that oxidation. Sometimes it is supplemented by small additions of iron ore. After Si, Mn and C have been reduced by oxidation to the required amounts, the slag, which is a multiple silicate of iron and Mn, is deoxidised by means of FeMn, which replaces the harmful FeO by MnO, and of a little lime which forms a calcium silicate. Due to the heat of the arc and to the presence of C in the metal, some of the silica of the slag is reduced in Si, which passes in the metal and helps to deoxidise and degasify it.

The electric furnace can also be operated with hot metal, and it is mostly used in that way for refining metal which has been melted and partly refined by another process.

For instance, what is called the *Duplex Process* consists in heating in a basic electric furnace, with a view to remove its S and P and thoroughly to deoxidise it afterwards, a charge of molten metal which has been blown in a Bessemer converter.

In the Triplex Process, metal blown in a Bessemer converter is transferred to a basic open-hearth furnace, where the P is eliminated, then to a basic electric furnace, where, in a reducing atmosphere, S is eliminated and the metal deoxidised. An *alternative* of the *Duplex Process* consists in heating in a basic electric furnace a charge of molten cupola metal, which may be obtained from "all scrap" charges in the cupola, no silicon being required.

This latter process would probably prove to be at the same time economical and capable of yielding steel of excellent quality. Cheap scrap could be melted in the cupola, where there is no special difficulty in melting 100 per cent. steel-scrap charges with some 12 per cent. melting coke, and the refining in the electric furnace of the cupola metal, would probably require, for a charge of, say, two tons, not more than 200 or 300 kw.-h.

Merits and Disadvantages.

From the point of view of the practical steel-founder, the best steel is that which possesses the greatest fluidity at the minimum temperature, with a sufficiently low S content to prevent red-shortness.

Fluidity, *i.e.*, the ability to run thin sections, is greater in converter steel than in electric or open-hearth steel of the same temperature. This is due probably to the presence of minute amounts of dissolved oxides, as evidenced by the fact that steel made in an electric furnace with only one slag, *i.e.*, the oxidising slag used to dephosphorise the metal, proves to have more fluidity at a given temperature than electric steel, in the melting of which both an oxidising slag (to remove P) and a reducing slag (to remove S) have been produced.

In the Bessemer acid process, the increase in the temperature of the metal coming from the cupola is due to several exothermic chemical reactions, the most important of which is the oxidation in SiO_2 of the Si contained in the metal, and one might reasonably suppose that these oxidising reactions are not quite completed when the metal is poured in the ladle (whatever care is taken in the deoxidation), but go on for a few minutes, thereby neutralising to some extent the loss of temperature of the metal, due to radiation in handling it from the converter to the moulds.

One can easily vary, at will, the temperature, and consequently the fluidity, of converter steel by suitably adjusting the Si content of the cupola metal. For instance, if the chief melter knows that the next heat he has to melt will be used to pour moulds with fairly heavy sections, no ferro-silicon additions need be made to the converter. If, on the other hand, he knows that his next heat will be required to cast very thin and intricate castings, he will make his steel hotter

and more fluid by adding, a few minutes after the beginning of the blow, enough FeSi in his converter to achieve this result.

Of course, the higher the Si content of the metal entering the converter, the longer the conversion will last, and the greater the metallic loss by projections will be. That is why the most economical method seems to so adjust the Si content of the metallic charge in the cupola as to obtain a metal just high enough in Si to be capable of being transformed in steel in the minimum amount of time and at the minimum temperature which experience shows to be required to cast efficiently the heaviest castings to be dealt with that day in the foundry. This ability to give greater fluidity for a given temperature of the metal is one of the advantages of the converter process. Another, and a very important one in these days of strenuous competition, is the low cost, specially when high scrap percentages are used in the cupola.

As far as purity of the metal produced is concerned, the basic electric steel comes easily the first, but its cost is considerably in excess of that of converter steel. The acid open-hearth comes second, and the basic open-hearth third, although P can, in this process, be reduced to a negligible amount, but it yields metal containing more non-metallic inclusions than acid open-hearth steel.

Acid electric steel may be placed in the same category as acid open-hearth steel.

Converter steel is certainly less pure than steel made by any other process, but if care is exercised in its manufacture, particularly at the deoxidising stage, metal can be produced which will give physical tests results well above the requirements of the most exacting existing specifications. In a foundry the main factor is to produce sound castings, and in the great majority of cases the steel-founder has more chances of doing so with the highly fluid converter steel than with thoroughly refined basic electric steel, for instance.

The Influence of Elements on the Physical Properties of the Metal.

Carbon.—Increases the tensile strength with increasing quantity, and at the same time reduces ductility.

Silicon.—Has no marked influence in ordinary steels, where it is present to the extent of only approximately 0.3 to 0.4 per cent.

Manganese.—Increases maximum strength without much reduction in ductility. Usually present to the extent of approximately 0.7 per cent.

Phosphorus.—Increases slightly the tensile strength without affecting appreciably the ductility. Over, say, 0.07 per cent. it becomes objectionable, causing brittleness at very low temperatures.

Sulphur.—It is advisable to keep this element as low as possible, in view of the fact that, if in excess of, say, 0.06 per cent., it has a tendency to induce red-shortness, viz., the formation of cracks in the castings when the metal is in a pasty condition and begins its contraction.

However, this red-shortness is only to be feared in the case of fairly thin or intricate castings, always assuming, of course, that S does not reach too high a percentage. Sulphur does not affect to any appreciable extent the physical properties of steel, viz., tensile strength—elongation—ability to be bent cold, as long as it is associated with Mn to form MnS. This MnS is formed in small spherical globules which, in a section etched with a weak acid, viewed under the microscope, appear as small circular areas of a characteristic dove-grey colour, but if S is present as FeS, then it becomes very detrimental, because this FeS takes the form of elongated beads, which act as nuclei to gather other non-metallic impurities, such as Al_2O_3 and silicates (of Fe and Mn), to form a composite body, which appear in etched section under the microscope as chain-like inclusions, forming some sorts of films around the pearlite, thereby creating weak crystal boundaries.

It is therefore very important to ensure, by proper manipulation of the steel when it is being finished, that enough Mn be added to satisfy as much as possible of the S present in MnS, and experience shows that to achieve this desirable result one must add something like ten times the theoretical amount of Mn required, because some of the Mn is lost through the formation of a carbide of Mn. Moreover, the greater the excess of Mn the easier will be the formation of MnS.

This very important difference between the deleterious influence of FeS as compared with MnS does not appear, unfortunately, to be sufficiently well understood by those responsible for issuing specifications governing steel. In every specification which has come to the author's knowledge, when a limit is assigned to the permissible amount of S in the steel, it is invariably stated that "the S content must be a maximum of, say, 0.05 per cent. or 0.06 or even 0.07 per cent.," without specifying that the S should be associated with Mn.

Now, numerous personal experiments on test pieces have shown that one may obtain much better physical results from a steel containing, say, 0.07 per cent. S in the form of MnS than from steel with, say, 0.03 per cent. S when this S is mostly in the form of FeS, all other constituents (C, Si, Mn, P) of these two steels being practically identical, the two test pieces having been subjected to the same heat treatment and showing under the microscope a similar amount of non-metallic inclusions.

It would seem, therefore, that it would be in the interest of the steel industry as a whole if, instead of limiting the total percentage of S in a steel, irrespective of its form of combination, either with Fe or Mn, and, eventually, determining the amount of S present by chemical analysis only, a microscopic test were specified in addition, which would show whether the S was present as the relatively harmless MnS or as the very deleterious FeS.

Far more detrimental than S and P (when these impurities exist in reasonable amounts) are the metallic oxides or silicates, the presence of which in a steel can only be detected by the use of the microscope, and all efficient steel makers would welcome a modification of present standard specifications, which would prescribe a micro-test in addition to the bare chemical test.

A Parade of Steam Wagons.

Transport being the vital connecting link between producer and consumer, if it be made difficult or rendered expensive, the producer must restrict his output because the cost of his product will then have risen beyond the means of the purchaser. To cheapen transport should be the aim of everyone, from the Government downwards, but, unfortunately, the Chancellor of the Exchequer, when introducing the Finance Bill of 1926, made a favouring gesture towards the railways and laid an extra burden of taxation upon road vehicles. By good chance, users of petrol vehicles were enabled to meet the extra charge by the unexpected cheapness of liquid fuel, but owners of steam vehicles had no such good fortune, and many vehicles of this type have stood unlicensed and idle all the year, drivers, driver's mates and maintenance engineers being deprived of employment and the demand for coal being lessened.

This country is generously endowed with stores of coal, and it would seem to be simple common sense that we should use for our transport needs, the home-produced fuel thus ready to hand instead of tending more and more towards dependence upon *imported* liquid fuels. In order to emphasise this argument, a demonstration of steam wagons is being conducted through the industrial districts of Lancashire, Yorkshire, the Potteries and the Midlands during the next two weeks. A dozen of the latest steam-driven vehicles, and one of particular interest which has been in hard, daily use for 14½ years, and has covered 200,000 miles, left Liverpool on Wednesday, November 9, and, covering about 50 miles per day, will travel via Wigan, Preston, Burnley, Bradford, Leeds, Barnsley, Sheffield, Huddersfield, Manchester, the Potteries, Stafford, Wolverhampton and Birmingham to London, where they will be on display on the day when the Commercial Motor Show is opened to the public.

To enable users of transport and others to see the vehicles, the route and the times of arrival in the different towns will be announced by the Press; at every town a halt of about half-an-hour will be made. The mayor and civil officials of many of the towns will greet the vehicles on their arrival—generally in front of the Town Hall.

The Dangerous Customer.

By G. J. JONES, A.R.C.Sc.I.

Some foundrymen there are who play a good hand at bridge, whilst others become proficient at golf or gardening. Yet others—the men to whom reference is made in the leader of October 6—their hobby apparently is to seek for and secure, not the largest number of small customers, but the smallest number of large customers—customers who will take the largest part of their output for the most months of the year.

The large customer—"unbalanced" production—appeals to the unbalanced type of mind. They are not confined to the foundry trade, these seekers after big things, they abound in all trades.

And "Oh," they tell us of their devourers, "a good customer. I'm sure of my money." "I know exactly to a hair's breadth what'll please him." "I don't have to employ travellers." "There's no bookkeeping, no worry, no trouble." And so they go on, these thoughtless manufacturers, manufacturing troubles as well as castings.

They dodge a few insignificant worries, they dodge thought, and eventually along comes the big worry—they lose their big, fat customer.

And with him they lose their self-respect. Down on their knees they go to the little men whom *once* they served. Instead of turning out castings, apologies are manufactured—mass production—and out these apologies go, but, alas! the small accounts, the life-blood of any business, the dispensers of the small orders, they refuse to be soothed.

Resolutions Passed.

And there is weeping and gnashing of teeth in the fireless foundry, and the boss, he broods and laments and burns the midnight oil; but he writes and makes rules. This is what he writes; here are his rules:—

(1) Never again shall I have a customer who takes a larger amount of my total business than is equal to my gross profits. He is a dangerous customer.

(2) If I am unfortunate enough to again get such a customer, I'll get rid of that part of his work which is least suited to my plant.

(3) If I cannot do that, I'll increase my business so that the big customer's share does not reach so far into the gross amount of my profits.

(4) Never again shall I lie awake o' nights thinking of my big customer, worrying about him, wondering how I shall please him.

(5) Never again shall I cringe and bow to the dangerous customer. Never again shall I give him the services which he expects but does not pay for. Never again shall I be afraid of asking him, "Who's the boss, you or I?"

(6) Never again shall I neglect Brown, and Jones, and Smith, and Smithkins, they were the life-blood of my business.

(7) And in the winning of these old, small customers back again I won't resort to price-cutting.

(8) Never again shall I tolerate the customer who is taking a third, or more than a third, of my total output.

The experience and the subsequent musings of this foundryman are not a dream. They have happened; and, alas! they will happen again.

The dangerous customer is the man who can instantly reduce your business 25 to 30 per cent. The dangerous customer is the kind of man who makes you feel afraid of him—makes you feel that you are no longer a free man. He makes you go about in fear and trembling, afraid even of your own shadow.

Don't be afraid of the little extra book-keeping. Don't be afraid of the little worries which always chaperon the small orders. Don't allow any man to absorb over 20 per cent. of your output—he's dangerous.

If you lose him you can smile. Don't resort to price-cutting to keep him. He will expect it, but don't do it. Smile when he flicks his fingers at you. You've still got enough business to keep going while you go about getting other business to fill the gap.

Don't put all your eggs in one basket. Twenty small customers are better than the one customer who buys as many as the twenty.

The Estimation of Iron in Aluminium Alloys.

By H. H. Shepherd.

Preliminary Work.

Reagents Required.—For this estimation one requires pure zinc drillings; a 1 per cent. solution of potassium sulpho-cyanate in water; N/10, N/20 and N/40 standard solutions of potassium permanganate; N/10, N/20 and N/40 solutions of sodium oxalate. The zinc drillings should be obtained from electrolytic zinc, and they should be as thin as possible. For the determination of iron by volumetric means the writer has used all three standard solutions of permanganate referred to above, but for specification alloys work the N/40 solution will be found most suitable; for scrap metal and mixed turnings, which may contain considerable quantities of iron, the N/20 solution is best. It is recommended that standard solutions weaker than N/10 be made by dilution of this solution, which is made direct from the solid salt. The method of preparing the potassium permanganate is as follows:—Sieve the crystals of the pure salt through a 30 sieve, and *use the crystals retained on the sieve* only for making the solution. Sieving reduces the liability of dust and other mechanically mixed impurities becoming included in the weight taken for the standard solution. It has been repeatedly noticed that when this precaution is taken, and the usual care exercised in making the solution, that the strength obtained is invariably exactly N/10. The sieved salt should be stored in a clean, dry bottle made of dark blue or brown glass, and fitted with a securely-fitting stopper, then labelled "Potassium Permanganate for Standard Solutions." The crystals should be clean and lustrous in appearance. Weigh exactly 1.580 grs. of the selected crystals, transfer them to a 500-c.c. calibrated flask, add about 250 c.c. of water (cold and distilled), then allow the permanganate to dissolve, aiding this by frequent shaking. When all the salt has gone into solution, dilute to the 500-c.c. mark.

Before standardising allow the solution to stand for at least two days; allow the N/20 and N/40 solutions made from this solution (N/10) to stand for the same length of time also.

Of the various methods adopted for the standardisation of potassium permanganate, the sodium oxalate method is undoubtedly the most accurate for ordinary laboratory purposes; this method is a modification of the oxalate method, but it is much more reliable. Sodium oxalate can be obtained in a very pure form, and it is far more stable than its acid, since the salt does not undergo decomposition on standing either in the solid or dissolved state; further, any traces of moisture absorbed (the salt is not hydroscopic, and it does not contain water of crystallisation) can be eliminated by heating to 120 deg. C. for about one hour, without any fear of causing decomposition.

N/10 Sodium Oxalate.—This is prepared from the dried salt (dried as above). Weigh off exactly 1,675 grammes, transfer to a 200 c.c. squat-form beaker and add 50 c.c. of water and 75 c.c. of 1 to 2 H_2SO_4; heat the solution to about 70 deg. C. until the salt is dissolved; cool the solution to normal temperature, transfer to a 250 c.c. calibrated flask and dilute it to the mark.

Standardisation.

To standardise the N/10 potassium permanganate, fill one burette with this solution and one with the N/10 sodium oxalate; 50 c.c. burettes are a convenient size, and they should have been washed out with a little of their respective solutions which they are to contain. From the burette containing the oxalate run exactly 20 c.c. into a 175 c.c. conical flask, add about the same volume of water and then heat to 80 deg. C., titrate immediately with the permanganate, shaking the flask during the additions. If the reaction becomes sluggish, warm the solution again to 80 deg. C. and continue to titrate. The titration is complete when one drop of the permanganate produces a slight pink coloration in the solution, and this remains permanent for at least one minute. If both the solutions have been carefully prepared from the pure salt, the result of the standardisation will almost invariably show that both solutions are equivalent in strength so that the potassium permanganate is N/10, and each c.c. of this solution is equivalent to 0.00558 gramme of iron.

If the potassium permanganate is found to be weaker or stronger than N/10, then the iron equivalent for each c.c. is obtained by multiplying 0.00558 by the decimal fraction the solution is of N/10, in the case of a weaker solution, and by 1 where X equals the fraction the solution is over, for solutions greater than N/10.

The N/20 and N/40 are obtained by dilution of a known volume of the N/19 potassium permanganate and sodium oxalate; it is advisable to run a check standardisation on the N/20 and the N/40 solutions of $KMnO_4$, to ensure that they are of correct strength, though if the dilution of the stronger solution has been made with care, they will be of accurate strength.

The Estimation.

The solution or filtrate, which is obtained from the filtering off of the sulphides of copper, etc., is boiled to about half to drive off the H_2S gas, then remove from the plate and add 30 c.c. of the dilute (1-2) sulphuric acid and evaporate to fuming. When the solution reaches low bulk (about 25 c.c.), it is advisable to move the beaker to a position on the hot plate, where evaporation can proceed gently, otherwise there is a danger of the estimation being spoilt owing to the solution "spattering." The salts separate out rather suddenly, and watch should be kept on the solution when its volume becomes low. Another cause of "spattering" is the use of too much H_2SO_4, 30 c.c. of this acid will not cause trouble in this direction if a little care is exercised when boiling the solution down; this amount also ensures the presence of sufficient acid to drive off other acids that have been used in the original silicon determination.

When the solution has evaporated to dryness, allow the residue to fume for five minutes, then remove the beaker and allow it to cool. Then treat the residue with 100 c.c. of hot water and boil to aid solution of the salts. When it is clear, showing that all the salts have dissolved, add about 5 grammes of the pure zinc drillings, stirring them with the liquid. As reduction of the iron takes place the solution will lose its colour gradually, until finally it becomes colourless. While this reaction is proceeding prepare a drop test plate; this is done by coating a white porcelain slab with a thin coat of clean paraffin wax, and then by the aid of a drop-tube—a piece of plain glass tubing—drops of the 1 per cent. potassium sulphocyanate are spaced on the plate. Porcelain tiles can be purchased which have depressions to take the drops; the use of this type of drop-plate will be found of considerable help and advantage over the home-made ones.

As soon as the solution appears colourless stir well and then insert the drop-tube. Withdraw a drop or two of the solution, taking care that little particles of zinc have not entered the tube, and allow one drop to fall on to the test plate so that it mixes with a drop of the sulphocyanate. If no coloration is produced the reduction of the iron is complete, and the solution is ready for filtering off any particles of zinc left. If on the mixing of the drops a red or salmon colour is produced, then the reduction reaction should be allowed to continue a little longer, while if the reaction has ceased more zinc must be added. Right up to the point of filtering there should be reaction proceeding between excess zinc and excess acid, so that re-oxidation cannot take place. It is essential, when reduction is complete, to filter rapidly; this is done by filtering through filter paper pulp or asbestos. In either case the filter pulp should be washed by suction three or four times with dilute H_2SO_4 immediately before filtering the iron solution. A 6-in. by 1-in. filter tube, connected to a 300 c.c. filtering flask and a filter pump, forms an efficient means for rapid filtering. After having washed out the flask and connected it to the pump again, filter the solution containing the iron; when the whole of the solution has passed through the pulp, wash the latter three or four times with hot water, then disconnect the filter flask, transfer the filtrate to a 250 or 300 c.c. conical flask; wash the filter flask, transferring the washings to the filtrate. Cool the solution to normal temperature; during the cooling, and until titration, cork the flask lightly to prevent as far as possible oxidation of the iron.

A blank estimation of the amount of iron present in the amount of zinc used should be made. To do this, dissolve the same amount of zinc as used for the reduction of the iron contained in the sample, in 20 c.c. of H_2SO_4, cool the solution after the reaction has ceased and titrate with the N/40 potassium permanganate. Note the number of c.c. of $K_2Mn_2O_8$ required to give to the solution a slight but permanent pink coloration.

When the sample solution of the iron is cooled, titrate as soon as possible and rapidly with N/20 or N/40 permanganate until, as in the case of the blank, the solution assumes a pale pink coloration, which is permanent for at least one minute. The number of c.c. of potassium permanganate required minus the number of c.c. the blank required × the iron equivalent per c.c. (0.00279 for N/20 and 0.001395 for N/40) × 100, and the quotient divided by 3.0 equals the iron per cent.

The German Steel Trust.

With the end of the financial year on September 30 the German Steel Trust (Ver. Stahlwerke, A.G.) has issued a statement showing the activity of the different departments during this period as compared with the previous six months from April 1 to September 30, 1926. The statistics of production of the main products are given in the following table, in metric tons:

Output.	1926–27. (Twelve months)	1926. April–September.
	Tons.	Tons.
Coal	26,081,321	11,823,928
Coke	8,204,880	3,086,601
Pig-iron	6,350,649	2,273,627
Steel	6,837,644	2,538,865

Concerning the position of labour, the report states that the number of workmen employed at the pits rose from 83,771 on September 30, 1926, to 88,732 on the corresponding date in 1927; at the iron and steel works the number increased from 86,667 to 94,342, while the number of officials at the mines advanced from 4,999 to 5,199, and that of the officials at the iron and steel works from 9,644 to 10,137 respectively in the same period.

The amount of the turnover in the twelve months is returned at 1,419,887,658 mks.; this total does not include the products sold to the different departments of the Trust's works. Of the above total, the inland market took 975,393,680 mks., and the export market 444,493,978 mks. The turnover of the mines, works and merchant companies in which the Trust holds participations is stated to have been about 1,000 million mks. during the year, of which about 900,000,000 mks. fell to the Trust's share.

The orders held by the iron- and steel-producing works and the finishing works on September 30, 1927, were equal to about 133 per cent. of the orders in hand on the corresponding date in 1926. At present the degree of activity both at the mines and works is satisfactory, and the orders will ensure the same degree of activity as in the final months of the past financial year.

The expected reduction in the costs of production has been realised by the continuation of the method of rationalisation begun at the formation of the Trust and by the technical progress achieved. The savings, however, have been largely absorbed by the increased social burdens, the advance in wages and a reduction in the length of the working shift, a development which was all the more felt, as the proceeds from the export business were adversely affected by the falling tendency in the world market for coal, iron and steel.

Guest, Keen & Nettlefolds, Limited.—Interim dividends for six months ended September 30, 5 per cent. per annum on first and second preference shares and 1s. per share on ordinary shares, all free of tax.

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Trade Talk.

BOUTILLIER PARTNERS, LIMITED, iron and steel merchants, 57, Bishopsgate, London, E.C.2, have removed to 13, Rood Lane, London, E.C.3.

THE SWEDISH GRANGESBERG COMPANY report shipments of iron ore totalling 790,000 metric tons during October as against 982,000 in September.

THE CENTENARY OF Marcelin Berthelot, the famous French chemist, was celebrated by a special Congress of Chemists held in Paris from October 23 to 26.

AT THE SHEFFIELD METALLURGICAL ASSOCIATION'S rooms, last week, a lecture was given by Mr. T. F. Russell on "The General Aspects of Die-casting."

THE FRENCH COLONIAL OFFICE has placed with the Saar works a contract for 12,000 tons of rails, on "contributions in kind" account, at a price of 150 golds marks (£7 10s.) the metric ton.

THIS YEAR to the end of October shipyards on the Tyne have launched 48 vessels of 211,411 gross tons, an increase of three vessels and 33,579 tons over the corresponding period two years ago.

THE FRODINGHAM IRON AND STEEL COMPANY, LIMITED, closed down one of their Appleby furnaces some time ago, and now J. Lysaght, Limited, have been compelled to close down one of their furnaces at the Normanby Park Works.

IN CONSEQUENCE of increasing demand it has been necessary to extend Petters' works at Yeovil. Extensions are being made in the machine department, and a new building is under construction for the erection and testing of the larger sizes of engines.

IN ORDER TO SUPPORT Swedish industry the Swedish State Railways some time ago placed a trial order of 1,000 tons of rails with the Stora Kopparbergs Bergslags Aktiebolag Ironworks. The rails have now been approved by the State Railways and will be laid at Gothenburg.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, have received an order from the British Tanker Company, Limited, for a steel self-docking floating dock for delivery at Abadan. The dock will be of the sectional pontoon type, and will be built at the Armstrong Yard, High Walker.

S. SMITH & SONS (M.A.), LIMITED, have acquired the business of the Robinhood Engineering Company, manufacturers of the K.L.G. sparking plug. There will be no change in the management, Mr. K. Lee Guiness still continuing as managing director, assisted by Major Carington and Mr. Hawthorn.

RUMOURS OF AMALGAMATION have been in circulation lately concerning Hurst, Nelson & Company, Limited. In connection with this the secretary of the company states: "As it is doubtful what may result from conversations which have taken place, the directors have nothing of a definite nature to report to the shareholders."

THE MACHINE TOOL TRADES' ASSOCIATION announce that in connection with the fourth Machine Tool and Engineering Exhibition at Olympia in 1928, 90 per cent. of the space on the ground floor, and a considerable amount of the space in the gallery, has already been allotted. After December 1 firms who are not members of the Association may make application for what space is left for goods other than machine tools, small tools and wood-working machinery.

THE LONDON AND NORTH-EASTERN RAILWAY COMPANY announce that contracts have been placed with the following firms for 41,500 tons of permanent-way steel rails for the renewal of their tracks during 1928: Cammell, Laird & Company, Limited, Sheffield; Steel, Peech & Tozer, Limited; Bolckow, Vaughan & Company, Limited; Dorman Long & Company, Limited; Partington Steel and Iron Company, Limited; Pease & Partners, Limited; Cargo Fleet Iron Company, Limited; Samuel Fox & Company, Limited; William Beardmore & Company, Limited; the Steel Company of Scotland, Limited; and the Barrow Hematite Steel Company, Limited.

MESSRS. BESSLER, WAECHTER & COMPANY, LIMITED, of Salisbury House, Finsbury Circus, London, E.C.2, announce that, owing to the prevailing tendency of founders making high-class castings to add steel scrap to their mixtures in fairly large quantities, and thus dispensing with the high-class and more expensive cylinder irons, making the need for an extremely low-sulphur iron more acutely felt than ever, they have, after extensive research, placed on the market a special grade of the now well-known "Lowcar" cylinder pig-iron. The sulphur is guaranteed at 0.01-0.02 per cent. maximum, and other elements being:—Total carbon, circa. 2.6 per cent.; silicon, from 1.7 per cent., as required; phosphorus, from 0.08 per cent., as required; manganese, 0.8 to 1.1 per cent. or 2 to 3 per cent. The usual grade with lower total carbon and silicon is still available. No doubt this will be of great interest to all founders, especially motor cylinder specialists, who are engaged in the practice of adding steel to their mixtures.

THE SHAREHOLDERS of the Chemical and Metallurgical Corporation, Limited, have passed the following resolutions: (1) "That with regard to any of the 9,500,000 at present unissued new ordinary shares referred to in the third and fourth resolutions passed on June 9, 1925, and confirmed as special resolutions on June 24, 1925, the directors be authorised to issue same as and when the directors shall determine in accordance with the articles of association." (2) "That the authorised number of directors be increased to twelve."

STATEMENTS describing the year to year advances in the consumption of tin as being extremely rapid, have been reported. It is pointed out that this assertion, continually being repeated, is not borne out by statistics. The figures relating to the mineral industry of the British Empire and foreign countries, and by the F.M.S. information bureau, indicate that the world production and consumption of tin has fluctuated between 110,000 tons and 145,000 tons during the past fifteen years, neither more nor less. The production during the past four years has been: 132,000 tons in 1923, 140,000 tons in 1924, 146,000 tons in 1925, and 142,000 tons in 1926, and since there has been no considerable alteration in stocks during this period, the world consumption may be taken to be approximately the same as production. This is the key to the anomaly that during these years tin consumption has apparently stood still while the consumption of lead and zinc has doubled. The world cannot consume more tin unless more tin is produced, and up to the present the increase in production has been very limited. In these circumstances, the price of the metal adjusts itself to the conditions of supply and demand. The fact that the price of tin remains comparatively high indicates the increase in consumption which would take place if the supply of tin was plentiful and cheap.

Personal.

MR. CHARLES M. SCHWAB has succeeded the late Judge Gary as president of the American Iron and Steel Institute, the latter having held that position ever since its inception in 1908.

MR. JOHN TIMMS, manager of the rail mill at the Barrow Hematite Steelworks, has celebrated his golden wedding. Apart for a little over two years' interval at the Moss Bay Steelworks he has been with the Barrow Company for 62 years.

MR. GEOFFREY STEAD, son of Mr. H. Stead, of Stalybridge, Manchester (secretary of the Lancashire Branch of the Institute of British Foundrymen), has won an open scholarship tenable for three years at the University at Manchester.

MR. S. E. DAWSON, foundry manager to Messrs. Ferranti, Limited, is severing his connection with that company on December 1 next, to start in business on his own account as a consultant on foundry engineering. His address is 8, Lynton Park Road, Cheadle Heath, Cheshire. Telephone: Cheadle Hulme 351.

Wills.

RICE, P. P., Northampton, managing director of Rice & Company (Northampton), Limited, The Eagle Foundry £12,864

HUMPHRYES, J. H., of Moorlands, Oldfield Road, Bickley, Kent, engineer, associated with Braithwaite & Company, Limited £212,749

Company Reports.

W. T. Henley's Telegraph Works Company, Limited.—Interim dividend on ordinary shares, 1s. 6d. per share, less tax.

Allen-Liversidge, Limited.—Dividend, 6½ per cent. per annum (less tax) for six months ended October 31, on preference shares.

Millom and Askam Hematite Iron Company, Limited.—Credit as result of nine months' operations, £84,877; deducting loss £20,318 from October 1 to December 31, 1926, there remains £64,558; net profit, £55,255; brought in, £24,627; available, £67,633; reserve, £40,000; dividend on preference for half-year, £12,250; carry forward, £15,383.

George M. Callender & Company, Limited.—Profit, £8,049; brought forward, £657; available, £8,041; usual dividends, £6 per cent. on preference and £10 per cent. on ordinary; further division of profits of two-thirds to preference shareholders and one-third to ordinary shareholders, making total dividend on preference shares of £10 per cent. and of £20 per cent. on ordinary shares, general reserve, £3,000; carried forward, £1,630.

Contracts Open.

Ayr, November 29.—(d) Bolts and nuts, screws, brake blocks; and (e) overhead line material, for 12 months commencing January 1, 1928, for the Town Council. Mr. W. Grant, tramway manager, Ayr Corporation Tramways, Town Buildings, Ayr.

Bogota, December 9.—Turntables, rails, fishplates, metallic bridges, pneumatic drilling sets, etc., for the Colombian Ministry of Public Works. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,420.)

Charlesworth, Glossop, November 29.—10,245 yds. of 5-in., 4-in., 3-in. and 2-in. cast-iron water main, for the Glossop Dale Rural District Council. Messrs. Brady & Partington, the engineers, Chapel-en-le-Frith. (Fee £5, returnable.)

Clacton, November 23.—75 tons of cast-iron pipes and specials to British Standard Specification, Class B, for the Clacton Urban District Council. Mr. S. Francis, engineer and manager, Gas and Water Department, Clacton-on-Sea.

Delhi, November 24.—Two gas engines, suitable for operation on producer gas, together with open-hearth-type producer gas plants, and two centrifugal pumps, for the Chief Controller of Stores, India Stores Department, Engineering Branch, Delhi. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,425.)

Dewsbury, December 12.—Pumps, motors, etc., for the Corporation. Mr. H. Dearden, borough engineer, Dewsbury. (Fee £2 2s., returnable.)

Dublin, November 23.—Three tons of white metal in ingots for bearings, for the Great Southern Railways, Ireland. The Company's Stores Superintendent, Inchicore, Dublin. (Fee 2s. 6d.)

Gosport, December 6.—Two 70-b.h.p. and one 130-b.h.p. crude oil engines, coupled direct to air compressors, with all wrought and cast-iron pipe connections, valves, etc., for the Corporation. Mr. A. Barlow, borough engineer, Town Hall, Gosport. (Fee £5 5s., returnable.)

Hastings, December 5.—(2a) One Turbo-alternator and (3a) one water-tube boiler, for the Corporation. Mr. A. J. Ryan, borough electrical engineer, "Electrical House," 12, York Buildings, Hastings. (Fee £1 1s. for each specification, returnable.)

Johannesburg, December 15.—Steel tyres for engines, tenders, carriages and wagons, for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,428.)

London, S.E.1, December 20.—(2) Bridgework, nine spans of 258 ft., for the India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.)

London, S.W.1, November 25.—Electric jib cranes, etc., for the Bombay, Baroda and Central India Railway Company, White Mansion, 91, Petty France, Westminster, S.W.1. (Fee 20s. each, non-returnable.)

Montevideo, February 5.—Five portal cranes of 5 metric tons capacity, 12 portal cranes of 3 metric tons capacity, and 5 without portal cranes of 2 metric tons capacity, for the Uruguayan Ministry of Public Works, Hydrographic Department. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,478.)

Pontypridd, November 26.—Steel mains and specials, for the Pontypridd Urban District Council. Mr. David Muir, engineer and manager, Gas Works, Treforest, Pontypridd.

Sydney, N.S.W., December 7.—One 5-ton electric overhead travelling crane and one 25-ton electric overhead travelling crane, for the New South Wales Government Railways, Chief Mechanical Engineer's Branch. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,447.)

New Companies.

John Downham & Company (1927), Limited, Barnbrook Ironworks, Fountain Street, Bury.—Capital £3,000. Engineers, millwrights, etc., carried on at Bury. Directors: G. Calvert, J. Lithgow and H. Heap.

Richard Ibbotson, The Sheffield Saw and Tool Company, Limited, Shoreham Works, White Croft, Sheffield.—Capital £5,000, to acquire business at Sheffield. Directors: W. Machin, J. A. Wiberg and H. Chadwick.

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Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—Slowly, but it is hoped surely, the Cleveland iron market is developing the improvement recently noted, and, with some relaxation of the pressure of Continental competition, is recovering from the gloom of depression existing throughout the past three-quarters of the current year. The more immediate difficulty with which Tees-side ironmasters have to contend is the resumption of active trading activity with Scottish consumers, and though offering a concession of 2s. 6d. per ton to buyers in that market, only a limited business has so far resulted, imported iron being much cheaper on the Eastern seaboard, and all that British producers seem to be able to do is to wait in the hope that Continental prices may further advance. That is not regarded as an improbable contingency, but, in any event, the Cleveland makers declare that they have reached their limit in regard to price-cutting, and that they cannot even consider the equalisation of prices as between home and foreign buyers. The firm attitude of the ironmasters is having its effect. At all events, business, though not exactly brisk, has reflected a little more animation recently. Buyers—or some of them—have evidently decided that they might risk purchases to cover their needs, at least up to the end of the year, and there is also a little more inquiry from abroad. Consequently prices are firm on the following basis:—No. 1 Cleveland foundry iron, 70s. per ton; No. 3 Cleveland G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

Keen competition continues the rule in the Tees-side hematite market, and some of the prices accepted would suggest an urgent need for orders. Makers apparently attempt to stabilise prices to the home consumers at 72s. per ton, or thereabouts, for mixed numbers, and 72s. 6d. for No. 1, but figures well below those are still being accepted for export orders. On the North-West Coast, however, prices are unchanged, Bessemer mixed numbers being quoted at 72s. to 73s. per ton at works.

LANCASHIRE.—As is usually expected at this period of the year, demand for foundry pig is below the average, and little change in these conditions may be anticipated during the next few weeks, as far as Lancashire consumers are concerned. Derbyshire makers are offering No. 3 iron for delivery in the Manchester district at from 73s. 6d. to 74s. per ton, whilst Staffordshire brands of foundry quality are obtainable at from 73s. 6d. to 73s. 9d. Cleveland makers are quoting 80s. 8d. per ton delivered, with Scottish at 89s., although up to 90s. is being asked in some instances.

THE MIDLANDS.—With pressure of demand relaxed to a great extent from seasonal causes, local markets for foundry pig are quieter than usual, with few changes in prices recorded in recent transactions. Quotations now rule as follow:—Derbyshire No. 3 foundry, about 65s. to 66s., f.o.t.; Northants No. 3, 60s. to 61s., f.o.t.; and North Staffordshire, at 65s., f.o.t.

SCOTLAND.—Light castings and pipe founders in this area are complaining of lack of orders, and consequently pig-iron markets remain inactive. Prices are nominally unchanged at 72s. 6d. for No. 3 foundry, f.o.t. furnaces, but for actual business this price can be reduced to the extent of probably 1s. per ton.

Finished Iron.

As this is hardly the time to expect much change for the better in market conditions for any class of finished material, it is not surprising to find business quiet in the extreme, with small prospect of improvement before the turn of the year. This is especially apparent in connection with crown and cheaper grades of bars. In certain directions, chiefly outside Staffordshire, this iron is quoted at £9 10s., whilst other prices run up to £10 5s. Marked bars are unchanged at £13 at makers' works, and the works are fairly well occupied at the moment. Nut and bolt iron quotations are about £9, but little support is possible at this level, as Continental No. 3 is so much cheaper.

Steel.

The Sheffield steel market is moderately active, and, on the whole, the position is satisfactory. There is a better demand for acid billets, and a freer buying of soft basic billets. Prices all round are unchanged. Open-hearth steel production is being further reduced, and the demand for crucible steel also shows a falling-off. Special and stainless steels, on the other hand, are showing a distinct improvement, and production of the former for export is just now on an important scale. The lighter industries in this district are making a better showing at present than the heavy sections. The tinplate market is only moderately active, with prices practically unchanged.

Scrap.

As usual at this period of the year, when old contracts are running out, business in scrap metal markets is negligible in volume, consumers hesitating to purchase to any extent, in view of price eventualities later on. At Middlesbrough, just now, there is no great abundance of heavy cast iron, but without any variation of price, small parcels still being purchasable at 65s. per ton for machinery quality and 61s. per ton for ordinary material. In the Midlands heavy cast-iron scrap is selling more freely at last week's figures —60s. for ordinary and 65s. for machinery, delivered. In Scotland, machinery cast-iron scrap is quoted 67s. 6d. per ton, and heavy ordinary 5s. per ton less, with railway chairs at 65s. to 67s. 6d., and light cast-iron scrap 57s. 6d. to 60s., all per ton delivered consumers' works.

Metals.

Copper.—Although quotations for standard copper at the week-end closed about 10s. per ton down, the decline is not regarded as serious, in view of the substantial decrease in stocks of rough metal held in this country, a speedy recovery being regarded as probable, and the outlook favourable to renewed activity in buying in the near future. The contango has now disappeared, and at times a backwardation of several shillings has been in evidence. Refined sorts have met a quiet home demand, but there has been a more active trade in electrolytic on the Continent, with France taking more interest than for some time past.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £58 2s. 6d. to £58 3s. 9d.; Friday, £58 3s. 9d. to £58 5s.; Monday, £58 12s. 6d. to £58 13s. 9d.; Tuesday, £59 1s. 3d. to £59 2s. 6d.; Wednesday, £59 6s. 3d. to £59 7s. 6d.

Three Months: Thursday, £58 3s. 9d. to £58 5s.; Friday, £58 3s. 9d. to £58 5s.; Monday, £58 11s. 3d. to £58 12s. 6d.; Tuesday, £59 1s. 3d. to £59 2s. 6d.; Wednesday, £59 6s. 3d. to £59 7s. 6d.

Tin.—Values of standard tin continue on the downward slope, due to the persistence of aggressive forward selling and anticipations of heavier shipments from the Straits next month, while American advices are at present none too favourable with regard to an immediate increase of consumptive demand in that country. Later information necessitates alterations in the figures of supplies and deliveries, as issued early in the month. The new figures are as follow:—Supplies: Straits shipments, 6,230 tons; Australian, 116 tons; Banca and Billiton, 1,813 tons; Chinese, 5 tons; standard arrivals in U.K. and U.S.A., 1,699 tons; total, 9,863 tons. Deliveries: U.K., 1,615 tons; U.S.A., 6,005 tons; Continent, 1,955 tons; other countries, 687 tons; total, 10,262 tons. The decrease in the total visible supply is 399 tons.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £257 5s. to £257 7s. 6d.; Friday, £259 15s. to £260; Monday, £264 5s. to £264 10s.; Tuesday, £261 17s. 6d. to £262; Wednesday, £262 12s. 6d. to £262 15s.

Three Months: Thursday, £251 5s. to £251 10s.; Friday, £253 12s. 6d. to £253 17s. 6d.; Monday, £258 to £258 5s.; Tuesday, £265 5s. to £265 10s.; Wednesday, £256 15s. to £256 17s. 6d.

Spelter.—The market for ordinary spelter remains dull and easy, transactions having mainly been of a professional nature. The American statistics created an unfavourable impression, showing an increase in stocks. In this country, however, stocks remain small, which accounted for the backwardation ruling for a considerable time.

The following are the week's prices:—

Ordinary: Thursday, £25 13s. 9d.; Friday, £25 16s. 3d.; Monday, £26; Tuesday, £26; Wednesday, £26.

Lead.—The home demand for soft foreign pig continues quiet, but the market has benefited of late from heavy Russian buying, which has exercised a steadying influence, and without which much lower prices might have been reached. Russian purchases on this market are estimated at about 10,000 to 12,000 tons, in addition to which she made large purchases on the Continent, especially in Germany, where stocks are much depleted.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £20 7s. 6d.; Friday, £20 7s. 6d.; Monday, £20 15s.; Tuesday, £20 15s.; Wednesday, £20 16s. 3d.

Book Review.

Elements of Machine Design.—Part I, by W. Cawthorne Unwin, F.R.S., and A. L. Mellanby, D.Sc. Published by Messrs. Longmans, Green & Company Limited. Price, 15s. net.

There are few better known or more appreciated text books on machine design than the one under review. It, unlike so many kindred works which have run into several editions, has invariably been subjected to thorough revision and has never been allowed to suffer from senile decay. The new edition has for instance taken proper cognisance of the utilisation of ball bearings—a development unknown when the book was first published. When dealing with cast iron, some of the elementary factors governing its design are well set out, and should at least be sufficient to make designers consult the foundry. The question of a small piece of sand being heated on two sides in such a way that it will retain the heat longer than the rest of the mould and so cause blow holes, and similar cases have necessarily to be omitted in a volume of this character. As co-operation must never be one sided, we insist that founders should study this and similar works in order to get the view point of the designer. Apart from this abstract aspect, the book contains much which is of direct interest to many of our readers, especially the pattern-shop managers and foremen.

Publication Received.

Nickel and Nickel Chromium Cast Iron as now Used in America, by T. Henry Turner, M.Sc. Published by The Bureau of Information on Nickel, Limited, 2, Metal Exchange Buildings, London, E.C.3. This is a really delightful publication, and incorporates all the best features of modern catalogue production. Those who have the good fortune to receive a copy will, we are convinced, regard it as a standard work on the subject of alloyed cast iron. A note on the front cover promises further similar papers, which no doubt will be eagerly sought after by every erudite member of the foundry industry.

American Exchange Paper.—The American Foundrymen's Association announce that they have invited Mr. John Howe Hall, M.A., of the Taylor Wharton Iron & Steel Company, to present the annual Paper on their behalf at the next annual meeting of the Institute of British Foundrymen, to be held in Leicester next summer. Mr. Hall is a graduate of Harvard University. From 1904 to 1906 he was connected with the Bethlehem Steel Company, and eventually became assistant superintendent of the crucible steel department. He was steel melter for the Buffalo Crucible Casting Company from June to October, 1906, and left this firm to become metallurgist for the Taylor Wharton Iron & Steel Company, where he remained until 1913. During 1913-1914 Mr. Hall was engaged in consulting engineering at New York, and from 1914 to 1915 he was engineer of tests for the Quigley Furnace & Foundry Company. Since 1915 he has been metallurgical engineer for the Taylor Wharton Iron & Steel Company. Mr. Hall has made many improvements in the manufacture and heat treatment of manganese steel and of carbon steel for severe requirements. He is author of "The Steel Foundry," a co-author of the "A B C of Iron and Steel," and has contributed many articles to the technical Press.

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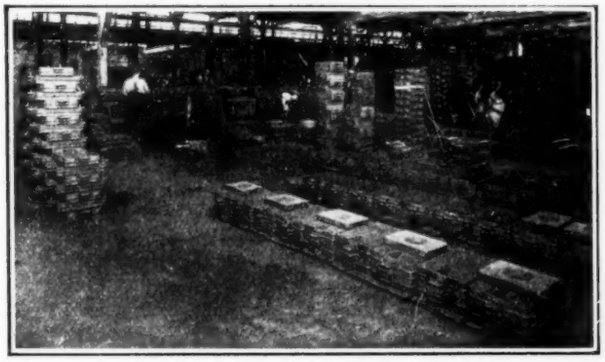

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BEDFORD

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	59	6	3
Three months	59	6	3
Electrolytic	63	15	0
Tough	62	10	0
Best selected	63	0	0
Sheets	88	0	0
India	73	10	0
Wire bars	64	5	0
Do. December	63	11	3
Do. January	63	11	3
Ingot bars	63	11	3
H.C. Wire rods	67	0	0
Off. av. cash, Oct.	55	3	0¾
Do. 3 mths., Oct.	55	5	3 7/16
Do., Sttlmnt., Oct.	55	2	11½
Do., Electro, Oct.	62	8	9
Do., B.S., Oct.	61	18	9
Aver. spot price, copper, Oct.	55	2	11¾
Do., Wire bars, Oct.	62	12	4¾
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9¾d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7¼d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	262	12	6
Three months	256	15	0
English	260	15	0
Bars	262	0	0
Straits	269	15	0
Australian	269	0	0
Eastern	260	5	0
Banca	271	0	0
Off. av. cash, Oct.	264	15	0¾
Do., 3 mths., Oct.	261	16	4½
Do., Sttlmt., Oct.	264	14	9¼
Aver. spot, Oct.	264	15	0¾

SPELTER.

	£	s.	d.
Ordinary	26	0	0
Remelted	24	15	0
Hard	20	0	0
Electro 99.9	30	7	6
English	26	7	6
India	22	0	0
Zinc dust	35	0	0
Zinc ashes	9	0	0
Off. aver., Oct.	26	15	3 13/16
Aver., spot, Oct.	26	17	11¾

LEAD.

	£	s.	d.
Soft foreign ppt.	20	16	3
English	22	0	0
Off. average, Oct.	20	14	3½
Average spot, Oct.	20	9	7

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	35	0	0
Do. V.M. ex whf.	33	0	0
Rods	42	0	0
Boiler plates	30	10	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	64	10	0
Chinese	42	0	0
Crude	37	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	23	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 17 6
45/50%	£12 15 0 to £12 17 6
75%	£20 0 0 to £22 0 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/– lb.
Ferro-titanium—	
23/25% carbonless	11½d
Ferro-phosphorus, 20/25%	£17 10 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 0 0
6/8% car.	£22 15 0
8/10% car.	£22 5 0
Ferro-chrome—	
Max. 2% car.	£35 15 0
Max. 1% car	£41 12 6
Max. 0.70% car	£53 0 0
70% carbonless	1/4 lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/11 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 0 0
76/80%, packed	£14 0 0
76/80%, export	£12 0 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/–lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Hvy. steel	2	18	6	to	3	0	0
Bundled steel and shrngs.	2	12	6	to	2	16	0
Mixed iron and steel	2	11	6	to	2	13	6
Heavy cast iron	2	17	6	to	2	18	6
Good machinery for foundries			3	2	6		
Cleveland—							
Heavy steel			2	17	6		
Steel turnings			2	5	0		
Cast iron borings			2	2	6		
Heavy forge			3	12	6		
Bushelled scrap			3	2	6		
Cast-iron scrap	3	1	0	to	3	5	0
Lancashire—							
Cast-iron scrap			3	5	0		
Hvy. wrought			3	2	6		
Steel turnings			2	2	6		

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	51	0	0
Brass (clean)	38	10	0
Lead (less usual draft)	18	0	0
Tea lead	15	10	0
Zinc	16	10	0
New aluminium cuttings	82	0	0
Braziery copper	47	0	0
Gunmetal	48	0	0
Hollow pewter	170	0	0
Shaped black pewter	130	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/–
Hematite No. 1	72/6
Hematite M/Nos.	72/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	91/–
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	65/–
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/6
,, fdry. No. 3	60/– to 61/–
Derbyshire forge	59/– to 60/–
,, fdry. No. 3	65/– to 66/6
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	72/6
Hem. M/Nos.	76/–
Sheffield (d/d district)—	
Derby forge	66/–
,, fdry. No. 3	68/–
Lincs. forge	66/–
,, fdry. No. 3	68/–
E.C. hematite	85/–
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	74/–
Northants foundry No. 3	—
Dalzell, No. 3	100/– to 105/–
Summerlee, No. 3	89/– to 95/–
Glengarnock, No. 3	89/– to 95/–
Gartsherrie, No. 3	89/– to 95/–
Monkland, No. 3	89/– to 95/–
Coltness, No. 3	89/– to 95/–
Shotts, No. 3	89/– to 95/–

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.	9	15	0	to	10	15	0
Angles						—	
Tees to 3 united ins.						—	
Nut and bolt iron					9	0	0
Hoops					12	10	0
Marked bars (Staffs.) f.o.t.					13	0	0
Gas strip					12	0	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	2	6	to	8	7	6
Boiler plts.					10	10	0
Chequer plts.					10	5	0
Angles					7	12	6
Tees					8	12	6
Joists					7	12	6
Rounds and squares, 3 in. to 5½ in.					7	15	0
Rounds under 3 in. to ¾ in. (Untested)					8	0	0
					and upwards		
Flats, over 5 in. wide and up					9	2	6
Flats, 5 in. to 1½ in.					8	2	6
Rails, heavy	8	2	6	to	8	7	6
Fishplates					12	10	0
Hoops (Staffs.)					10	10	0
Black sheets, 24g.					10	7	6
Galv. cor. shts., 24g.					13	12	6
Galv. fencing wire 8g. plain					12	10	0
Billets, soft	£5	15	0	to	6	10	0
Billets, hard					8	2	6
Sheet bars	£5	12	6	to	5	15	0
Tin bars	£5	12	6	to	5	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2¼
Sheet to 10 w.g.	1 2¾
Wire	1 3½
Rods	1 2¾
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/– to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	19.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	16.00
Basic	20.00
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.70
Sheets, blue an'l'd., 9 and 10	2.10
Wire nails	2.50
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box		17/6
,,	28×20	,,		35/–
,,	20×10	,,		—
,,	18⅞×14	,,		—
C.W.	20×14	,,		16/7½
,,	28×20	,,		—
,,	20×10	,,		—
,,	18⅞×14	,,		—
Terneplates	28×20	—	per box basis f.o.b.	

SWEDISH IRON.

Bars, hammered, £18 10 0 to 19 0 0	
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63½%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov. 10 ..		58	2	6	dec.	12/6
,, 11 ..		58	3	9	inc.	1/3
,, 14 ..		58	12	6	,,	8/9
,, 15 ..		59	1	3	,,	8/9
,, 16 ..		59	6	3	,,	5/-

Electrolytic Copper.

		£	s.	d.		
Nov. 10 ..		63	5	0	No change	
,, 11 ..		63	5	0	,,	,,
,, 14 ..		63	10	0	inc.	5/-
,, 15 ..		63	15	0	,,	5/-
,, 16 ..		63	15	0	No change	

Standard Tin (cash).

		£	s.	d.		
Nov. 10 ..		257	5	0	dec.	22/6
,, 11 ..		259	15	0	inc.	50/-
,, 14 ..		264	5	0	,,	90/-
,, 15 ..		261	17	6	dec.	47/6
,, 16 ..		262	12	6	inc.	15/-

Tin (English ingots).

		£	s.	d.		
Nov. 10 ..		256	10	0	dec.	20/-
,, 11 ..		259	0	0	inc.	50/-
,, 14 ..		262	15	0	,,	75/-
,, 15 ..		260	0	0	dec.	55/-
,, 16 ..		260	15	0	inc.	15/-

Zinc Sheets (English).

		£	s.	d.		
Nov. 10 ..		35	0	0	No change	
,, 11 ..		35	0	0	,,	,,
,, 14 ..		35	0	0	,,	,,
,, 15 ..		35	0	0	,,	,,
,, 16 ..		35	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Nov. 10 ..		25	13	9	dec.	2/6
,, 11 ..		25	16	3	inc.	2/6
,, 14 ..		26	0	0	,,	3/9
,, 15 ..		26	0	0	No change	
,, 16 ..		26	0	0	,,	,,

Lead (English).

		£	s.	d.		
Nov. 10 ..		21	15	0	No change	
,, 11 ..		21	15	0	,,	,,
,, 14 ..		22	0	0	inc.	5/-
,, 15 ..		22	0	0	No change	
,, 16 ..		22	0	0	,,	,,

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS.

Year.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1885	44 0	44 1	43 2	43 1	42 10	42 6	42 6	42 0	42 2	42 1	43 0	43 8	42 11½
1886	43 3½	42 0	42 0	41 6½	41 2½	40 0	40 0	41 2½	41 6	44 0	44 0	44 9	42 2½
1887	49 6	48 9½	45 6	43 2½	43 6½	44 1	44 0	44 2½	43 5½	44 6	41 9½	45 0	44 0½
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	295 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	—	—	—

* No prices available.

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